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SOME OF THE FACTORS DETERMINING THE COMMON CONTENT OF HIGH SCHOOL CHEMISTRY.

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During the past few years much has been written and said about the use of standard tests of achievement. Before one can intelligently set about measuring the results of teaching chemistry in the high school, it is necessary to get as clear a conception as possible of what it is that is going to be measured. The sort of chemistry that is taught in the average high school today is determined by what has been taught in the past and by what the moulders of today's opinion think ought to be taught.

Chemistry in the American secondary school is a heritage from the past. Some of the industrial applications of the science were made in this country soon after the first settlements were established. It is said that glass, for example, was manufactured in Jamestown, and sent to England as early as 1609. As a subject for academic study, however, it did not make its appearance until more than a century and a half later.

Before the year 1800 in this country there were several associations of men, concerned with chemical and other scientific problems. Among these were the American Philosophical Society, founded by Franklin in 1744, The Chemical Society of Philadelphia, founded by James Woodhouse in 1792, and the American Academy of Arts and Sciences, founded in Boston in 1780. Although these societies discussed problems in chemistry, neither they nor the private laboratories to which students were admitted were, in a strict sense of the word, institutions for imparting instruction in chemistry.

As a study for schools, chemistry first made its appearance in this country in medical departments of universities. It is first mentioned in the curriculum at Columbia University in

1767, at the University of Pennsylvania in 1769, and at Harvard College in 1783[1]. The courses were not limited to students of medicine, for men from other departments of the institutions were allowed to register. Very soon, however, it was made a study in the senior year of the arts course both in universities with medical departments and in colleges without them. As indicative of the tendency to introduce chemistry it may be noted that as early as 1800 it was required of all candidates for the degree of Bachelor of Arts at Columbia[2], was placed in the original curriculum at the University of Georgia[3] when it opened its doors to students in 1801, and was introduced at Bowdoin College in 1805, three years after it was founded[4].

With the introduction of specialization in courses and of laboratory work, in about the eighteen-forties and fifties, elementary chemistry in the colleges was moved down from its position in the senior year to the junior and sophomore years and finally to the freshman year.

Institutions of collegiate standing were not the only places where chemistry might be studied in the early years of the nineteenth century. This was a time when popular lectures were much in vogue. The lyceum lecturer, with his discussion and experiments, offered the public an opportunity to learn about chemistry. In addition to the lectures, textbooks were written for those who attended the lyceum and for the general reader. Through means such as these, chemistry got a grip on the imaginations of the people and aroused a demand that the study be offered in the academies.

The academies were established in recognition of a need of a broader education than that provided by the Latin grammar schools. The founders desired that they might prepare students not only to enter college, but also to take an influential place in whatever sort of civil life they elected to follow. Through such means as popular books and lectures there developed a notion that chemistry could make a material contribution to preparation for life in the world of commerce. This state of mind was reflected by an author of a textbook of the day who argued that: "from the present state of our chymical knowledge, and the

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[1]History of Columbia University, 1754-1904, p. 310. Quoted by S. R. Powers, A History of the Teaching of Chemistry in the Secondary Schools of the United States Previous to 1850, p. 5. Clarke, Frank W., A Report of the Teaching of Chemistry and Physics in the United States, Bureau of Education, Circular of Information, No. 6, pp. 205, 207, 209.

[2]Medical Repository for 1800, published at New York by Drs. Mitchell and Miller, p. 205. Quoted by John Maclean in the History of the College of New Jersey, Vol. II, pp. 10-11.

[3]Clarke, F. W., op. cit., p. 201.

[4]Clarke, F. W., op. cit., pp. 201 ff.

improvements which are daily making in our arts and manufactures by the application of its principles, it is become absolutely necessary to make chymistry a part of the education of every youth who is designed for a manufacturing trade, or who is likely to figure in the higher ranks of life[5]."

While this state of mind had been developing many of the early academies had departed from the broad ideas of the founders and had become schools preparing only for college. As such, their curricula were rigidly prescribed and every student's time was filled with classics and other required studies. When the public demand for chemistry became very insistent, not a few academies established English departments in which the sciences were included. Such a department was set up at the Phillips Academy at Exeter in 1808[6] and at the other Phillips Academy in 1830[7]. Leicester Academy had done the same thing in 1813[8], and Nazareth Hall had first offered chemistry in 1790[9].

Since teachers for the academies were recruited from the colleges, it is not unnatural that elementary courses of study in the two institutions should have been similar. For the same reason, methods of instruction were very much alike. For example, individual laboratory work was introduced into the college courses about 1850; twenty years later it was beginning to be a popular means of instruction in the academies.

Because of the success of teaching chemistry to college freshmen and to academy seniors, and because of the continued popular demand for opportunities for a larger number of boys to study the science, it began to be introduced into the high schools of the country at about the beginning of the second quarter of the nineteenth century. At the Boston English High School, instruction in chemistry was probably given as soon as the school was opened in 1821[10]; at Newburyport, in 1825[11]. The public high schools, never enthusiastic to devote themselves to educational experimentation, were apparently watching the development of the teaching of the subject in the colleges and universities and, following the lead of the academies, were beginning, soon after the middle of the century, to expand their

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[5]Parkes, S. A., Chymical Catechism, 1807, pp. xiii ff.
[6]Catalogue of Phillips Exeter Academy, 1783-1869, p. xvii.
[7]Catalogue of the English Department in Phillips Academy, Established as a Seminary for Teachers, October, 1832.
[8]Washburn, Emory, Brief Sketch of the History of Leicester Academy, 1855, p. 24.
[9]Clarke, F. W., op. cit., p. 189.
[10]The Prize Book, No. IV, of the Publick Latin School in Boston, 1823, pp. 16 ff.
[11]Clarke, Frank W., op. cit., p. 173.

courses by the introduction of laboratory work. At the high school in Lowell, Massachusetts, laboratory instruction was begun in 1866[12], and in many other high schools and academies it was added during the next few years.

From this brief historical sketch the inference may be drawn that some of the reasons for introducing chemistry into the secondary school were not essentially sound. In the first place, it seems to have been put there because the public had been pleased with the results of the study of the subject in the colleges. The academies, and later the high schools, were expected to give to those who could not go to college a training of more advanced nature than that offered by the common schools. The colleges were giving instruction in chemistry; therefore, the secondary schools patterning after the colleges, also included chemistry in their curricula. In the second place, chemistry was introduced into the secondary school to satisfy a popular demand. Through the lyceum lectures and others, the man on the street had become interested in the mysteries of chemistry. He seems to have thought that the riddles of the science would be more quickly solved by increasing the number of students of its elementary branches. He was doomed to disappointment on this score, however, for the secrets of chemistry are not uncovered by novices but by research workers with thorough and extensive training. In the third place, there was a popular belief in the practical advantages to be derived from chemistry by those going into business and into mechanical pursuits. The chances to apply chemistry to life were highly regarded by the public but little taught in the schools before the beginning of the twentieth century. In the early days, chemistry was presented as a pure science, and the applications of its principles were left to each student's own devices.

Although there were some unsound reasons for the introduction of the subject into the schools in these earlier times on the other hand, there were sound reasons for introducing and retaining it. Some of these are found in values derived from its study. In former days, teachers rated transfer values more highly than do teachers of our day. Whatever the attitude toward formal discipline may have been, it may be true that training in observation, in classification of facts, in generalization, and in accuracy of statement, was one of the outcomes of the study in former as in present times. No one can doubt that these traits, developed

[12]Report of the School Committee, Lowell, 1867, pp. 31-32.

in connection with the subject matter of chemistry, may be dissociated and applied by the same human mind to other data of a similar nature.

When chemistry was introduced into the secondary schools it held somewhat the same position in the public mind that radio holds today; it was a subject of widespread interest and a topic for popular conversation. Not to know something about it was not to be educated or cultivated or worthy of membership in the "higher ranks of life." In this narrow sense it had certain cultural values. In a broader meaning of the term, it helped then, as it does now, to give those who studied it a foundation for an interpretation of the phenomena of nature with which they were constantly surrounded.

Furthermore, chemistry was of value as a preparatory subject for those who later were to go to college. At first this number was not large, primarily because schools where chemistry was taught were not preparatory schools. Boys who were intended for a higher education were prepared in a classical school or the classical department of an academy where chemistry was not taught. Those who went to the high schools or the English departments of the academies ordinarily did not go to college. In these later days, with the more flexible college entrance requirements and with the increase in the number of boys and girls who prepare for college in the high schools, the value of chemistry as a preliminary study has increased. Nevertheless, even today, of all high school pupils who study chemistry the college contingent is relatively small. For the few who do go to college its value as a preliminary study is real.

Finally, to those who studied chemistry in the secondary schools, there was given an ample basis for appreciating the work of the specialists in the science, the inventors and originators. It was not expected that many would ever become specialists in chemistry; certainly not that any would become such as a result of their secondary school course. Even so, the work of the school gave them a background against which they could project, measure, and assess the work of others. This outcome of chemistry teaching, important in the early days of the expansion of scientific interests, is equally valuable today.

In the chemistry teaching of these early days, then, as in the chemistry of today, we find certain values; transfer values, somewhat overrated in the early days, cultural values, propaedeutic values, and appreciative values. In these derived values

were valid reasons for making the study a part of the curricula of secondary schools and reasons for keeping it so. Furthermore, the selection and arrangement of material of instruction, so that these values might be obtained, in a measure brought about the common content of courses and similar methods of teaching.

In addition to these reasons, chemistry has remained a constituent of the curricula of secondary schools partly on account of the weight of scholastic precedent; partly, because of the inertia of public opinion; and partly as a result of an injection of new aims, ideals, and purposes into the course. Greek is perhaps the most outstanding illustration of the retention of a subject through scholastic precedent. From a status where it was required of all, it had fallen, by 1915, to a state where only about a quarter of one per cent of pupils in the public high schools were studying it. Yet it was retained in the curriculum of many schools and was taught if a sufficiently large number of pupils elected it. The feeling that "what was good for me is good for my son," has been operative in retaining not only Greek but also other studies in the curriculum. Although the influence of scholastic precedent has been less pronounced in the keeping of chemistry in the curriculum than in the retention of Greek, it has been very real and in part accounts for the presence today of formal, academic chemistry in the secondary school.

The inertia of public opinion toward chemistry may be illustrated by the situation that developed in the Boston English High School. In 1833, the subject was to be "allowed in the first class, if the master think proper to introduce" it.[13] Three years later it was required and continued so to be until 1852.[14] At this time it was dropped by the school committee from the ists of required and elective studies, probably as the result of a suggestion by a subcommittee that perhaps the English high school had become too exclusively scientific.[15] That the committee's action required a change in public opinion greater than could be made is evident in the fact that, in 1858, chemistry reappeared as a required study,[16] and has been an offering of the school ever since that time.

There was a much more important reason than either precedent or inertia for keeping chemistry in the curricula of secondary

[13]Regulations of the School Committee, Boston, 1833, p. 16.
[14]Ibid, 1836, p. 19.
[15]Annual Report of the School Committee of the City of Boston, 1854, p. 44.
[16]Regulations of the School Committee, Boston, 1858, p. 49.

schools. This was the establishment of additional aims, purposes and ideals for the course. Recently these have been set forth by two committees appointed by the National Education Association.[17] They propose more complete and worthy living for all youth. To accomplish this, chemistry should contribute to the realization of at least six main objectives. These are: (1) an improved state of individual and community health, (2) an ability to perform many of the services that make an individual a worthy member of a family, (3) a preparation and a guidance so that each may select his vocation wisely, (4) an increased respect for the expert and his services to society to the end that each may act well his part as a member thereof, (5) a genuine appreciation of nature so that one's leisure hours may be worthily used, and (6) an exaltation of truth in the development of ethical character.

These new aims and ideals do not diminish or destroy the values that have long been attached to chemistry. The transfer and cultural values have not decreased with the expanding science, and its value as a study preparatory to further work and as a background for the appreciation of the research of others has not grown smaller. In addition it has been hoped that chemistry teaching might be vivified by a development of its material aspects so that it should be valued as the bringer of prosperity and power to the individual and to the nation. This is a direct value that was hoped for chemistry from the start. To make it more certain, new courses have been organized that depart from the traditional ones, which were patterned after the pure science of the colleges. Among these are the technical courses and those designed for girls about to undertake domestic responsibilities.

Perhaps more important than the material value of chemistry is its influence on the human spirit. Says J. J. Thomson: "A nation thoroughly trained in scientific method and stirred with an enthusiasm for penetrating and understanding the secrets of nature would no doubt reap a rich material harvest of comfort and prosperity, but its truest reward would be that it would be fitted by an ample and generous education to perform justly, skillfully, and magnanimously the offices both private and public of peace and war."[18] In order that this re-

[17]Cardinal Principles of Secondary Education, U. S. Department of the Interior, Bureau of Education, Bulletin, 1918, No. 35, pp. 10-11. Reorganization of Science in Secondary Schools, U. S. Department of the Interior, Bureau of Education, Bulletin, 1920, No. 26, pp. 12-14, 36-37.

[18]Thomson, Sir J. J., Natural Science Teaching in Great Britain, U. S. Department of the Interior, Bureau of Education, Bulletin, 1919, No. 63, p. 9.

ward might the more surely accrue to the nation, courses of a more general nature have been outlined for which have been written textbooks with such titles as "Chemistry of Common Things" and "Practical Chemistry."

No one can question the value of these courses. The fact remains, however, that they are far from universally found in secondary schools. The sinister influence of the institutions of higher learning in defining and delimiting the scope of the work to be presented as credit for entrance to their halls is so great that the new aims and ideals cannot be completely satisfied. For those who are going to continue their study, the college requirements must be met. The majority of secondary schools are so small that not more than one course in chemistry may be offered. If there are any students in the class likely to go to college the nature and scope of the course are usually determined by the college requirements. In a few larger schools, with registrations of several hundred, it may be possible to offer on the same or alternate years two or more courses whereby those not going to college may study a type of chemistry more fitted to their needs. To be sure, teachers attempt to modify their work so as to approach the ideals that they have set for themselves, but the academic shackles prevent a realization of these ideals in any large way.

Within the limits set by the colleges and universities, the content of chemistry courses may be widely variant. A recent unpublished analysis[19] of text books, designed for students of chemistry in the secondary schools, shows great differences, for example, in the offering of equations. Six books[20] were examined and found to contain 2,607 equations. Of these, only thirty-four occurred in all, and as many as 731 were found in only one of the six books. The number of different equations in each book varied from 170 to 555, with 325 as the average. That there are equally wide variations in other phases of the subject is not to be doubted. One reason for this is the vast extent of chemical knowledge from which one must choose in making up a year's course or in writing a textbook. During 1922 nearly 2,300

[19]By D. A. Prescott, Harvard Graduate School of Education.
[20]These were:
Black and Conant, Practical Chemistry.
Brownlee et al., First Principles of Chemistry.
Dull, C. E., Essentials of Modern Chemistry.
McFarland. B. W., A Practical Elementary Chemistry.
McPherson and Henderson, An Elementary Study of Chemistry.
Newell, L. G., General Chemistry.

discoveries in chemistry were recorded in *Chemical Abstracts*. Few of these will ever get into the elementary textbooks, and still fewer will appear there within a few years. The field of chemistry is constantly growing, however, and the range of choice of material for secondary school students increases year by year.

Another reason for variation in the content of courses is in the origin of the textbooks. Many of our secondary textbooks are written by professors in the higher institutions. The choice of material for their college courses and for their college texts is not delimited by any specific regulations imposed from above. They are free to teach what to them seems essential. When they prepare their textbooks for secondary schools, they usually give each topic less extended treatment, sometimes by simply making cuttings from the larger volume. This may be illustrated from the laboratory standpoint by material taken from a recent study by Koos[21]. He made an analysis of the content of five laboratory manuals for chemistry; two used in colleges and three used in high schools. Two of the high school manuals were written by the authors of the college manuals studied. The experiments with sulfur and sulfur compounds may be used as illustrations of the general situation. The college manuals contained an average of 40 1-2 subexperiments in this group, while the high school manuals contained an average of 23 1-3 subexperiments only. With a considerable variation in the experiments contained in manuals designed for college classes and with individual prejudice employed in the selection of experiments to be incorporated in the derived high school manuals it is a matter for wonder that such small differences in the range of high school experiments are found among the appropriate books.

Variations in courses and in textbooks is not to be condemned without a hearing. It is a natural law that variation results in improvement. In nature, the variant that is most fitted to survive, survives. In chemistry, to determine what should be retained as a part of the desirable body of chemical knowledge for the secondary school student, there must be some way of measuring its value, its teachableness, and its effectiveness. At the present time there are no adequate means of doing this.

Courses in chemistry, as actually taught, do not show such

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[21]Professor L. V. Koos kindly loaned the writer the manuscript of a chapter on the overlapping of high school and college chemistry that is to form a part of his study of the junior college movement. His investigation was made under subvention by the Commonwealth Fund of New York City.

large variations as the foregoing might imply. There is a unifying influence in the syllabi of state and city departments and in the requirements of the College Entrance Examination Board. Yet, with these unifying factors, there is far greater variation in twelfth grade chemistry than there is, for instance, in fifth grade arithmetic. For this reason, among others, standard tests in chemistry have been developed more tardily than tests in arithmetic and have appeared in lesser numbers.

A century or more ago there was great popular interest in the new science of chemistry. Public attention was directed to the study by the activities of scientific associations, by the prescription of a year's work in the science for college under graduates, and by the popular, experimental lectures delivered on the lyceum platform. In the early part of the nineteenth century, chemistry was tried out in the academies, and found adapted to the abilities of pupils of secondary school age. Whereupon, in the early years of the second quarter of the century, it began to appear in the curricula of the high schools. Since that time, constant investigation in the field has widened its scope with the result that today the scondary school can present but a mere fragment of the total knowledge about the subject. This expansion might have resulted in courses for secondary schools entirely unrelated to one another. At the same time that these forces tending toward divergence have been operating there have been working unifying influences in the syllabi of cities and states and the requirements of examining boards. These two diverse influences have produced courses in chemistry in America secondary schools that are far from sterotyped but that have a content, sufficiently common to make possible a comparative measurement of the results of teaching.

RED MEN CHOOSE RED AS FAVORITE COLOR.

The red man's fondness for gaudy color schemes has long been known but it has remained for Dr. T. R. Garth of the University of Denver to scientifically ascertain the color preferences of the Indians in the Southwest.

Full blood Indians were found to prefer red to all other colors, then blue, violet, yellow, and white in the listed order. White men, living in the same social and educational environment, preferred blue, then green, and then red.

The education of the red man has little apparent influence upon his favorite colors. The squaws and the braves agreed more closely in their select colors than the whites and the Indians did. The full blood Indians were found to be very emphatic in their color preferences, much more so than the mixed bloods and the whites.

METHODS AND HELPS IN TEACHING HIGH SCHOOL CHEMISTRY[1].

By W. Segerblom,

Phillips Exeter Academy, Exeter, New Hampshire.

When I was asked to speak to you at this meeting and the title suggested was "Methods in High School Science" I told your chairman that I would probably have to confine my remarks to such topics as bear more particularly on chemistry teaching since unfortunately I do not teach either general science or physics. In coming before you with a few items which I have found of considerable help in my own work I trust that you may find something in them which you can apply in the general science and physics work. Although it has been my privilege to specialize on the teaching of secondary school chemistry I count it my loss that such specialization has prevented me from keeping as fully in touch with the other sciences as I should have liked.

Prof. B. S. Hopkins of the University of Illinois in a paper he read at the Milwaukee meeting of the American Chemical Society last September stated:

"A good teacher is the most important factor in any chemical course of study. Expensive laboratories, elaborate equipment, costly reference libraries, superior text-books, and skillfully arranged courses of study are of little value in the teaching of chemistry unless they are presided over and administered by the mind of an individual who knows and loves chemistry and who has some skill in the science and art of imparting his knowledge to others."

Prof. Hopkins then went on to describe the training which the chemistry teachers in one of the Middle Western states have had for their work, not only to make authoritative chemists of them but also and primarily to make teachers of them. The results showed that outside the large accredited high schools there was a great tendency on the part of the school authorities to assign the teaching of chemistry to any teacher whose schedule was short regardless of his fitness for the job. Whether this condition obtains in other parts of the country than those in which Dr. Hopkins was interested was not brought out, but the American Chemical Society has gone on record as urging colleges and universities of the country to provide better facilities for the training of teachers of chemistry, since such teaching

[1]Read before the Department of Science Section, Maine Teachers Association, at Portland, October, 1923.

is a highly technical profession requiring both a knowledge of the science of chemistry and of the art of teaching.

Whether the unsatisfactory condition noted above holds in our part of the country is a matter of concern more to the school authorities than to us. Let us consider for a few moments some of the methods which the chemistry teacher may employ and a few of the many helps which are available to him in making his chosen subject mean something to his pupil.

TEACHING METHODS: A paper read before a recent meeting of the Section on Chemical Education of the American Chemical Society brought out that it is possible to begin the study of chemistry with metals instead of with non-metals. The speaker said:

"I have never been able to understand why practically all texts written for the beginner in chemistry start in with oxygen, hydrogen, the gas laws, and water to be followed soon with atoms, molecules, symbols, formulas and equation writing. It has always seemed to me more logical to start, not with gases but with some solids, such as metals, with which the student may have had some slight acquaintance before entering the class. It is my belief that the ordinary student can at first get more tangible results from the more tangible substances, and that introducing him from the start to gases which he can hardly see, smell, taste, or handle is likely to discourage him from the start, particularly if these introductory substances are tangled up with that bugbear to so many students—the gas laws. A splendid opportunity is lost to tie the subject from the beginning in the student's mind to things that he has handled, or can handle easily in everyday life."

A plan was then outlined for starting with such common metals as copper, zinc and iron, leading from the properties of these and some non-metals like sulfur, carbon, chlorine and phosphorus to the subjects of oxidation and combustion and then taking up acids formed from some of these and the action of these acids on some metals and metallic compounds. This series of about ninety experiments led up to an investigation of a substance saltpeter, the composition of which was unknown to the student. This substance he investigated by means of sulfuric acid and by appropriate experiments on the distillate with the result that by this procedure he determined for himself the composition of both saltpeter and of nitric acid. All of this work was completed without the mention of atom or molecule and without a chemical symbol or formula.

Now, the above, which was apparently successful, is contrary to the methods employed in the stereotyped texts, but it is worth considering because it shows we have not yet reached the last word on the teaching of chemistry and it behooves the secondary school teacher of chemistry to be courageous in trying out any method which seems to him likely to yield better results.

LECTURE EXPERIMENTS: Lecture experiments should of course be made very incidental to the laboratory experiments individually performed by the students. Since every teacher naturally likes to do some lecture experiments it is fitting to mention *Chemical Lecture Experiments* by Benedict (Macmillan. $2) as this is by all odds the best book on the market on this subject. The directions have been worked out with care in much detail and there is a multitude of experiments from which to select.

Prof. Herbert F. Davison of Brown University has devoted himself during recent years to working up new lecture-table demonstrations. He has shown some of these at meetings of the New England Association of Chemistry Teachers. The snappy manner in which he ran off the experiments and the fact that everything "worked" to perfection made his experiments an inspiring experience even for the cut and dried teachers before whom he showed them. The directions for these have been published in various reports of the New England Association of Chemistry Teachers. It is hoped that he will put them in book form later. To give an idea these titles are quoted from the Report of the May 1921 Meeting: "Gas Diffusion Apparatus," "A Dust Explosion," "A Simple Fire Extinguisher," "Ignition Point of Carbon Bisulfide," "Action of Aluminum and Iodine and Freezing with Ammonium Nitrate."

The teacher would do well to select such experiments as drive home *general methods* and *general principles* as much as possible. It is also wise not to do too many so-called fireworks experiments.

It is also wise for the teacher to try out the lecture experiments before class each year no matter how often they have been done. If they don't work when you do them before the class, don't bluff. Try the experiments again or if time is short postpone them to the next meeting of the class and then repeat them successfully, explaining why they didn't work the first time. At all times be honest with the students.

It saves a lot of the teacher's time if the apparatus can be kept set up from year to year.

LABORATORY EXPERIMENTS: A recent survey of New England chemistry teachers showed that they are very positive that a first-year course in chemistry should not be attempted without individual laboratory work. In most schools laboratory work accompanies or precedes the text work on the topic being studied. It need hardly be said that individual work in the laboratory helps fix the topics in mind because it is a study OF THINGS not ABOUT THINGS.

Quantitative experiments are usually not favorites with the students, and sometimes not with the teachers, but a few certainly ought to be given because chemistry is an exact science and is governed by laws, some of which lend themselves well to experimental demonstration. From the dozen or more usually found in laboratory manuals the following are presumably most often selected: Per cent of Water of Crystallization, Reacting Weight of a Metal, Weight of a Liter of Oxygen, Per cent of Oxygen in Potassium Chlorate, and Composition of Air by the Phosphorus Method. Each teacher must of course decide upon the proper limits of error consistent with the apparatus at hand and the ability of his students. Above all things these limits should not be made so close as to encourage doctoring of results.

Note-books seem to be a mooted question, but at present over fifty per cent of the chemistry teachers in New England seem to prefer a blank bound note-book in which the student writes his record in his own words. More detailed information on this will be published during the coming winter in the Report on the Laboratory Questionnaire by the New England Association of Chemistry Teachers.

Double laboratory periods are often helpful if they can be arranged though it is not necessary if periods are of forty-five to fifty-five minutes duration.

Free periods for the chemistry teacher are most necessary in which to prepare for lecture experiments, to get ready for laboratory periods, and to read the current chemical literature. Progressive school authorities recognize this fact and do not require as many hours of actual teaching of the chemistry teacher as of the teachers in other subjects.

The personality of the teacher counts for much. If the students are to be taught to see experimental results exactly as they present themselves and to refuse to allow themselves to be prejudiced in their observation by what the book says, they should see in the teacher a shining example of this attitude of mind.

LABORATORY HELPS: The progressive chemistry teacher is always on the lookout for all kinds of devices which will shorten his labors and save time.

One convenient device is data cards for quantitative experiments. Of the half-dozen shown let me quote from the one on the combining number of magnesium. It calls for the following numerical results: Weight of magnesium, barometer reading, thermometer reading, volume of hydrogen as measured, volume of hydrogen at standard temperature and pressure, weight of hydrogen, and the combining number of magnesium. If these items are arranged on the card so that the numerical results fall in a column, the teacher can tell at a very quick glance if the results hang together, and if they do not whether the student has gone astray in reading some of the instruments or in the calculation of his results. This device is particularly valuable in large sections where the teacher can ill afford to spend much time hunting for the results in the student's record as it is ordinarily made. The teacher can thus quickly direct the student to look over again this or that part of the work as the figures indicate.

Students who offer chemistry for Harvard have to pass a laboratory examination in the subject. This has led some teachers to give their classes a laboratory examination two or three times a year in which the student is expected to work without the aid of manual or note-book. The device is of value even in non-Harvard classes. The sample sheet shown on which the student records his results includes sketches of apparatus used, equations for all reactions taking place in the experiment, the chemical name and the common name (if any) and either the symbol or the formula for each factor and for each product figuring in the experiment, a half-dozen selected properties for each factor and product, a description of the procedure used, a record of all observations and the significance of each. A few typical experiments suitable for such a laboratory examination are the preparation of some common metallic salt, the reaction between an acid and a metal and between an acid and a salt, to oxidize lead and then reduce the oxide back to lead, to make copper sulfide by synthesis and then by metathesis, to make two yellow metallic compounds, and to prepare two different metals from their nitrates.

CHARTS of various sorts are often an efficient means of instruction. Some of these can be purchased from the supply

houses, and others can be obtained from industrial concerns, often for the asking. The International Salt Company of Scranton, Pennsylvania, has a small but good chart on the *Uses of Salt.* The Barrett Company, 17 Battery Place, New York City has a chart covering *Coal Products and Their Uses.* Prof. Lowy through the Van Nostrand Company has published a similar but two-colored *Coal Products Chart.* The U. S. Industrial Chemical Company, 110 East 42nd Street, New York City, has brought out a splendid chart on *Uses of Ethyl Alcohol.* Some chemistry of a more theoretical nature is shown in the *Chemical Nomenclature Chart* (Exeter Book Publishing Company, Exeter, N. H.) which shows the derivation of the names of the elements and the method of forming the names of the different classes of chemical compounds. Prof. Silverman has brought out through the Van Nostrand Company a large wall chart of the *Periodic System* showing Moseley's Atomic Numbers. This lists for $6 but the publisher has brought out a miniature on a 21 by 28 cm. leaflet which can apparently be had for the asking.

The U. S. Department of Agriculture has published some excellent *Food Charts* in colors, too large to show here. The Solvay Process Company has brought out a chart entitled *The Alkali Tree,* showing by the branches 150-175 compounds and uses derived from the ground substances coal, limestone and salt. The Semet Solvay Process Company of Syracuse, New York, has published a similar *Coal Products Tree.*

These are simply a few illustrations of what can be obtained by looking around.

MUSEUM OR COLLECTION: A collection of chemicals and specimens illustrating the application of chemistry to manufactures and other industries is most helpful. Exeter is fortunate in having such a collection which, during the past twenty-five years, has grown to several thousand specimens. For convenience it is divided into three parts—(1) the elements, (2) the compounds, and (3) the arts and manufactures. The first two divisions are largely of theoretical interest, because the elements and compounds are arranged according to their scientific classification. Much, however, of practical value and of technical interest as interwoven, for the substances stand side by side on the shelves as they are made in the laboratory, as they occur in nature, and as they are used in technical processes.

The third division of the collection is of practical interest primarily, and shows how the substances classified in the other two divisions are used in the various industries. This division

naturally covers a very wide field and contains many exhibits donated by manufacturers. There is a chance here to include many specimens which at first glance belong primarily to other sciences.

A 14-page article describing in detail various phases of working up such a collection was published in the April 1909 number of School Science and Mathematics and a catalog of all specimens added up to 1914 has been published by the Department of Chemistry of the Phillips Exeter Academy. Copies of this catalog can be obtained for the asking by addressing the Department.

CHEMISTRY LIBRARY: A chemical library with some of the recent reference books and more reliable popular books on chemistry is almost as necessary as a good stock of apparatus. This should be added to with a few volumes each year according to resources at hand.

Several good book lists have been published:

The New England Association of Chemistry Teachers a few years ago published *A Chemistry Library for Secondary Schools*, a 16-page pamphlet comprising a list of chemistry books suitable for secondary schools and such as might arouse the students' interest. It is not a list of text-books but rather of books written in popular style, free from the text-book idea and essentially reliable. It is divided into three main divisions, general, industrial, and household chemistry and ten other less well defined divisions. Each book mentioned is described briefly in from one to five lines. There is appended a suggestive twenty-five dollar list for small libraries and a fifty-dollar list for libraries commanding a little more money.

A similar list of books suitable for students of physics in secondary schools was drawn up by a committee of Chicago teachers and published in School Science and Mathematics, February, 1916.

The speaker is not aware of any similar list suitable for general science classes but Mr. Walter G. Whitman of the Salem Normal School, Salem, Massachusetts, Editor of the *General Science Quarterly*, should be able to give information on books suitable for general science students.

CHEMICAL READING COURSES: A 26-page pamphlet published by the American Chemical Society is a very different kind of list. It was drawn up at the request of some city librarian who wanted a series of pamphlets which could be dis-

tributed free to patrons wishing to know what to read on chemistry. It is drawn up in conversational style and treats of elementary, household, general, physical, inorganic, analytical, organic, biological, industrial, and technical chemistry. The best books are mentioned in the text under each division and then a supplementary list is appended to each.

The New York Chemistry Teachers' Club has published a 6-page list called *Chemistry References for Students and Teachers.* This is somewhat similar to the New England Association of Chemistry Teachers' list. It gives more titles but does not give any descriptive information about the books.

The Chemical Engineering Catalog (leased at $2 per year by the Chemical Catalog Company, 19 East Twenty-fourth Street, New York City) contains a splendid list of technical and scientific books relating to chemistry. It covers 100 pages 17 by 27 cm. in size. It is arranged alphabetically by authors and contains in addition to the usual statistical data either the table of contents or a short descriptive paragraph. The list is also arranged alphabetically by subjects so that it is possible to see at a glance what books have been published upon each subtopic.

It is not out of place to mention in this connection the U. S. Bureau of Education, Bulletin No. 26, 1920, entitled *Reorganization of Science in Secondary Schools.* This embodies the results of seven years' work of the Commission appointed to draw up the report. It covers the four subjects—General Science, Biology Physics and Chemistry. It does not contain a complete outline of subjects to be studied but shows by a few type topics the character of the reorganization recommended and the method of teaching suggested.

The State of Pennsylvania is working upon a COURSE OF STUDY IN CHEMISTRY. The tentative draft of the report shows that it will be a very valuable addition to the chemistry teacher's working material. In addition to some general matter of a very helpful nature there is a very fully itemized outline of topics. It will well repay chemistry teachers to write to the Department of Public Instruction at Harrisburg, Pennsylvania, for a copy of this report.

One should not neglect to mention the so-called New York Regent's Syllabus published as a part of a pamphlet, *Syllabus for Secondary Schools; Physical Science* by the State Department of Education, Albany, New York.

CHEMICAL SOCIETIES: It is most helpful to the science teacher to belong to one or more of the various scientific societies which take up subjects of direct interest to the science teacher. There is the double benefit of course of getting not only the scientific material presented at the meetings but of equal if not greater importance the opportunity to rub elbows and rub ideas with fellow workers.

THE NEW ENGLAND ASSOCIATION OF CHEMESTRY TEACHERS: Was formed nearly a quarter of a century ago and has been in active operation ever since with at least three meetings a year and with printed reports of each meeting. It was probably originally designed primarily for the benefit of secondary school teachers of chemistry but there has been a splendid spirit of co-operation between the college and high school teachers. Mr. S. Walter Hoyt, 20 Stone Road, Belmont, Massachusetts, is President of the Association and will be glad to correspond with any who are desirous of joining. The printed reports of the meetings contain full minutes of the meetings and usually the complete addresses of the speakers. It is active in various other ways. It conducts excursions to industrial plants periodically and tries to get the opinions throughout New England on various subjects of immediate concern. An example is the recent Questionnaire on the Laboratory which will soon report on the Function of the Laboratory in present-day chemical instruction.

THE EASTERN ASSOCIATION OF PHYSICS TEACHERS: Is a similar organization devoted to the interests of physics teachers. Mr. Alfred M. Butler of Practical Arts High School, Boston, Massachusetts, may be addressed for information about this society.

THE CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS: Is a strong organization of the teachers in the Middle West, of which region perhaps Illinois might be considered the center. Its annual meeting comes during Thanksgiving time and lasts for a number of days, with separate sections for the different sciences. SCHOOL SCIENCE AND MATHEMATICS is the official organ of this association. It is also the official organ of numerous other associations of science teachers, the list of which may be found on the advertising pages of this periodical.

Membership in the American Chemical Society is highly desirable for the teacher who specializes on chemistry or with whom chemistry is first choice although that teacher may be temporarily teaching other subjects as well. With its 15,000

members it embraces most of the chemists in the United States, industrial as well as teachers, and its semi-annual meetings are sources of great inspiration to the 1,000 or more who are usually in attendance. It publishes three journals, (1) *The Journal of the American Chemical Society,* a monthly publishing papers on research in general, physical, inorganic, organic and biological chemistry, with book reviews and records of the Society; (2) *Industrial and Engineering Chemistry,* a monthly publishing more new and important articles and papers on industrial chemistry and engineering chemistry than any other language, together with American and foreign current and news notes; and (3) *Chemical Abstracts,* a semi-monthly giving carefully classified abstracts of all important new work in chemistry published in the world. Although these journals are more or less technical they are exceedingly valuable in keeping the teacher up to date in his subject. The annual dues are $15 and entitle each member to all three journals published by the Society and full privileges of the local sections within whose territory they reside. Teachers interested should address the Secretary, Dr. Charles L. Parsons, 1709 G Street, Northwest, Washington, D. C.

One of the numerous divisions into which the Society is divided for convenience at the semi-annual meetings is the Division on Chemical Education. This is a very energetic division and before it have been presented during the last few years numerous papers on the teaching of chemistry in high school and in college. The correlation of high school and college chemistry is the subject at present under discussion. That the Society is trying to contribute something constructive is shown by the fact that its Committee on Chemical Education has just completed its first draft on an outline for a Standard Minimum High School Course. The committee consists of three secondary school men, three college teachers and three industrial chemists so that the Outline shall represent the concensus of opinion. This Outline will be published in the November issues of *Industrial and Engineering Chemistry* and of SCHOOL SCIENCE AND MATHEMATICS. The Committee is planning to put this Outline before the high school teachers in every state of the union for criticism and comment. The committee will then publish the final outline in the light of such criticism as the wish is that this outline shall represent the majority opinion of teachers throughout the country. Within a few weeks New England teachers will receive a copy of this Outline with a letter requesting their opinion.

PERIODICALS: SCHOOL SCIENCE AND MATHEMATICS is perhaps the best periodical for the high school teacher of science because it publishes articles on all the sciences usually taught in high school, namely, agriculture, astronomy, biology, botany, chemistry, geography, general science, mathematics, physics and zoology. The price is $2.50 per year. It is published by Smith and Turton, Mount Morris, Illinois, business office, 2059 East 72d Place, Chicago, Illinois. The chemical articles cover methods, status of chemistry teaching, teaching devices, new experiments and current statistical items on chemical substances. The October number contains a good article on "What Chemistry Shall Be Taught in High School and How Shall It Be Correlated with College Chemistry," by L. W. Mattern of Washington, D. C., a member of the Committee on Chemical Education of the American Chemical Society.

The journals published by the American Chemical Society have already been mentioned. The records in these of the meetings of the Division of Chemical Education naturally appeal most to the high school teacher. The record of the Milwaukee meeting may be found on page 3 of the September 20, 1923 issue of the News Edition of *Industrial and Engineering Chemistry.*

Science is the official organ of the American Association for the Advancement of Science. It is published by the Science Press, Grand Central Terminal, New York, at $6 per year. An interesting part of this publication just now is the publication in it of the "Science News" of Slosson's *Science Service.* This service as you know is up to the minute reliable news on the most recent scientific events. A recent issue contained three-quarters of a page on Element No. 72 and whether it should be called "celtium" or "hafnium."

SCIENCE CLUBS: In many schools Science Clubs are found distinctly helpful in keeping alive the scientific interest of the scholars. In the October 1923 issue of SCHOOL SCIENCE AND MATHEMATICS J. A. Lewis in an article entitled EXPERIENCES WITH SCIENCE CLUBS tells very fully what has been accomplished in New Brunswick, New Jersey Senior High School.

The *Monthly Guide for Science Teachers,* associated with *Popular Science Monthly,* about a year ago published a series of articles on the formation of Science Clubs in high schools and listed a number of popular programs.

COLLEGE ENTRANCE EXAMINATION BOARD: This Board conducts each June examinations in sixty different sub-

jects covering mathematics, history, the languages and the sciences. In 1921 the 18,000 or more chemistry candidates prepared at about 1,800 different high and other secondary schools and intended to enter about 200 different colleges. This involved about 2,000 chemistry teachers. It is therefore easily seen that the College Board chemistry requirements has considerable influence over the teaching of chemistry in many high schools. *Document No. 105* of the College Entrance Examination Board, 431 West 117 Street, New York City contains the Chemistry Syllabus. The Board realizes that the cresent Syllabus does not match up well with the present-day status of the subject. It therefore has appointed a commission to revise the present Syllabus. This Commission is anxious to get comments of all interested teachers on the present Syllabus with suggestions for improvement. A request for such help has been published recently in a number of scientific and educational periodicals. Maine teachers who have any opinions on this Syllabus are earnestly requested to send their opinions to the Chairman of the Commission, Prof. Percy T. Walden, Department of Chemistry, Yale University, New Haven, Connecticut.

School and Society for September 29, 1923, has published a paper read before the American Chemical Society at its New Haven meeting, entitled "What the College Board Chemistry Examination Is Doing For the Teaching of Chemistry." This paper discusses the Chemistry Syllabus, the setting and marking fo the papers and the effects of all this on the teaching of chemistry in secondary schools.

GARVAN PRIZE ESSAY CONTEST: At the Milwaukee meeting of the American Chemical Society announcement was made that the Society will conduct a nation-wide prize essay contest among high and secondary school students as a result of a gift from Mr. and Mrs. Francis T. Garvan in honor of their daughter Patricia. Six thousand dollars of this is to be expended in awarding in each state six prizes of $20 in gold to the students in all secondary schools, public and private, for the six best essays evidencing an understanding of the importance of chemistry in our national life. Four thousand dollars additional to defray the expenses of the contest. Mr. and Mrs. Garvan have further given $20,000 to establish six four-year scholarships in chemistry or chemical engineering at Yale University or Vassar College to be awarded to the highest of the successful contestants in the prize essay contest. These scholarships will

carry $500 a year and tuition. Further information may be obtained from the Chairman of the Committee in charge of the contest, Dr. H. E. Howe, 810 Eighteenth Street, N. W., Washington, D. C.

CO-OPERATING WITH THE PUBLIC: The wide-awake chemistry teacher will find various methods of co-operating with the public or of interesting the public in things chemical. This can best be done along the line of such substances as figure prominently in the daily news or touch the life of the community in some other way.

During the war an exhibit of desiccated foods was made up in the Chemistry Department at Exeter, were described briefly in the local paper and an invitation was extended to interested housewives to inspect the exhibit. It was shown and described at a meeting of the local Woman's Club.

The use of potash salts as fertilizers and their production from American sources suggests itself as particularly suitable in certain localities.

The chemistry teacher is often welcomed to give short interesting talks before local clubs, parent-teachers organizations, etc. It goes without saying that the topics should be of vital interest to the audience.

One Massachusetts teacher of High School chemistry has addressed his local Board of Trade.

CONCLUSION: These rambling comments on very disconnected topics simply indicate that there are plenty of devices and means for the teacher to use in making his teaching of the subject as efficient as possible.

When all is said and done the keystone of the art is the teacher. In closing let me quote a few lines from the Pennsylvania Report referred to above, not with the idea that any in the audience needs to be preached at but rather that we may remind ourselves anew of the spirit in which we all are probably unconsciously doing our teaching:

"The ultimate degree of success of a course in chemistry must be judged by the extent to which it has served to develop character in those who have taken the course. To insure this success the earnest teacher makes certain, for one thing, that all questions are answered directly and to the point—usually he is able to guide the minds of the students themselves to correct solutions of their problems. He seeks particularly to avoid any form of evasion in his discussions and answers; if the information

available at the time is not sufficient for the purpose, he does not hesitate to say so. He is convinced that of all the lessons to be learned in classroom and laboratory, the greatest is a profound and lasting respect for truth. He encourages at all times the spirit of co-operation which animates all successful organizations; he sees to it that every student has ample opportunity to develop initiative and express individuality accompanied by proper self-restraint. In such an atmosphere, great and noble careers may have their inception, and the teacher may well deserve to be called a real leader."

It may be anti-climax for me to add anything personal to the strong statement just quoted but I cannot refrain from leaving this thought with you that we science teachers, because of the nature of our work, have a most exceptional opportunity to drive home to the students some of the ideas touched upon in the quotations with which I opened and have closed my remarks. If any of the little helps and devices which I have touched upon are in any way suggestive of a little easier or a little more efficient way of conducting your work then I shall feel amply repaid for putting them before you.

SUBMARINE SLIP CAUSED JAPAN EARTHQUAKE.

The devastating earthquake in Japan undoubtedly originated in part in the sea off the coast of that island empire, in the opinion of Prof. Andrew C. Lawson, of the University of California, who has just come to Washington to head the National Research Council's division on geology and geography.

A great break in the ocean bottom occurred, allowing one side to slip past the other and drop for probably a dozen feet, carrying with it many millions of tons of sea water. The ocean rushing into the vacated space set up the so-called tidal waves that, oscillating back and forth like water in a tub, swept the Japanese coast, Dr. Lawson explained. The violent shaking of the earth that caused destruction and started the fires was a result of the slipping of two portions of the earth's crust past each other.

The extremely deep portions of the oceans seem to be associated with the areas where earthquakes are most frequent, Professor Lawson pointed out. Just off the east coast of Japan is a long depression in the ocean's floor, called the "Tuscarora deep." Similar depths of the sea, found off Chile, the Philippines, Jamaica and the Aleutian Islands in Alaska are regions where earthquakes are frequent.

Earthquakes occur when strains in the earth's crust become too great and find relief in slips and breaks, Professor Lawson said. He likened the crust to a board that when stressed by a weight will finally give way with a sudden crash. The rocks of the earth are elastic like steel and will stand a certain amount of strain before they are relieved by sudden movement.

Japan is noted for the progressive piling up of strains that result in earthquakes. Professor Lawson recalled the quake of 1891 in Japan that left an abrupt cliff, as high as eighteen feet in some parts of the zone.

A JOURNEY INTO THE FIELDS OF GENERAL SCIENCE[1].

BY H. A. WEBB,

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I. *In which I hear a criticism.*

Not long ago I listened to a school man telling what he thought about general science. He said it was untimely, inappropriate, uninteresting, stale repetition, plagiarized from other books, stolen from other sciences; that its authors were disreputable poachers upon other fields, thieving professors, faddists, bootleg purveyors of science, professional parasites, grave robbers, Rip van Winkles who are still asleep, childish experimentors who purposely adulterate and dilute instruction, hot-air artists, wet nurses to pampered yappers who are fast degenerating into idiocy, and—

Now I wish I could say that at the climax of his tirade this commentator had a stroke of apoplexy. But no such luck! As has been said of another orator, he

> Had hands to wave, a tongue to flap,
> And gleaming teeth to grind 'em,
> A throat with chords too strong to snap,
> And leather lungs behind 'em!

But I, who fell in love with general science as far back as 1908, felt that I should venture a feeble protest. "My gentle sir," quoth I—

"Shut up!" he snapped, "What do *you* know about it!" And this to me, a school teacher!

Out of his continued vehemence I gradually gathered his principal point of grievance; that however interesting general science texts might be, the experimental part, *those things which children were called upon to do,* were largely borrowed from other sciences already established in the high school.

II. *In which I resolve to refute it.*

"*What* do you know about it? What do *you* know about it? What do you *know* about it?" That is good questioning! So started the gathering of facts to defend general science against this criticism; to happily prove that this subject introduces a child to everyday science in unique, distinctive, and appropriate ways. I would cheerfully show that it seeks the natural instead of the artificial, prefers the fresh to the stale, and displays the genuine object instead of the diagrammatic model. With this purpose in view, I examined nineteen general science

[1]Offered before the General Science section, Association of Science and Mathematics Teachers, Indianapolis, December 1, 1923.

texts and manuals now on the market. The earliest one was published in 1915, the latest in 1923.

The experiments in every book were carefully examined, one by one. First, each experiment was classified. Having busied myself for many seasons with the various high school sciences, I recognized any standard exercise in physics, chemistry, biology, etc., even if partially disguised. But I was ever on the lookout for unique experiments, different from those I had so frequently used in high school books.

Second, the source of apparatus and material called for in each experiment was listed. For example, a stewpan, looking glass, fruit jar, hammer was marked in a column headed *the home;* shot, wire, electrical equipment, seeds, plaster of paris, was listed as coming from *a store;* logs, flowers, soil are found in *the forests and fields;* blood, saliva, the eye, are *personal.* But if the experiment called for a beaker, a burette, a sonometer, test tubes, etc., such items were considered as distinctly *laboratory equipment.* Homes do not possess them, and you cannot buy them at the neighborhood store.

III. *In which I strain a point.*

In my eagerness to prove that general science uses the practical materials of everyday life, I have, perhaps, not been quite fair. I must make my small confession— I must conceal nothing. I have listed apparatus under the *home* and *store* columns if they could possibly be found there, even though every laboratory contains them. For example, if the manual called for "a beaker *or* pan," I listed the pan from home and not the beaker. "Burner" was marked as from home, but "Bunsen burner" was necessarily assigned to the laboratory. Soda, borax, ammonia, salt, candles, and the like are to be found both at home and in the laboratory, but the home got the credit in all instances. The physics laboratory has cat's fur, but the home has the cat, or a flannel cloth; so the home is again favored. The only excuse I make for this bias is that I was terribly anxious to prove my point, and thus I leaned—do you not give your earnest beliefs the benefit of every favorable construction?

IV. *In which I discover some facts.*

The figures of Tables I and II tell most of the story. In the typical General Science text or manual, fifty-nine per cent of the experiments are those regularly performed in high school physics, chemistry, and biology laboratories; less than one-third of them are unique, not already definitely incorporated

TABLE I. DEFINITE NATURE OF EXPERIMENTS IN GENERAL SCIENCE TEXTS.

Text	Unique Indoors	Out of Doors	Library	Physiology and Biology	Chemistry	Physics
	%	%	%	%	%	%
A	54.9	2.4	5.6	8.4	11.9	16.7
B	41.9	9.5	7.4	10.8	12.4	17.9
C	41.7	0	0	16.5	12.1	29.7
D	39.3	.9	15.2	3.6	22.3	18.7
E	39.0	3.7	5.5	7.4	29.6	14.8
F	36.1	.9	0	.9	21.8	40.3
G	35.1	27.6	10.5	4.5	9.0	13.4
H	32.8	9.8	7.1	1.7	26.4	22.0
I	31.7	10.0	0	13.3	25.0	20.0
J	30.9	4.7	.8	16.2	23.3	24.1
K	29.9	11.9	15.0	13.4	10.4	19.4
L	27.8	13.9	2.5	18.8	12.3	24.6
M	27.5	7.5	.6	8.7	15.6	40.0
N	22.9	1.8	1.8	31.1	22.9	19.3
O	18.3	12.4	8.0	13.1	23.4	24.8
P	18.0	.9	0	15.3	23.4	42.4
Q	15.0	5.8	13.3	25.0	15.0	25.8
R	11.1	2.0	1.0	3.0	25.2	57.6
S	3.0	18.2	9.1	21.2	18.1	30.3
Median	30.9	5.8	5.5	13.1	21.8	24.1
Average	29.3	7.6	5.4	12.2	19.0	26.4
Highest	54.9	27.6	15.2	25.0	29.6	57.6
Lowest	3.0	0	0	.9	9.0	13.4
Average Deviation	9.4	5.5	4.4	6.4	5.5	8.1

TABLE II. SOURCE OF MATERIAL FOR EXPERIMENTS IN GENERAL SCIENCE TEXTS.

Text	Home and Environment	Store	Field and Forest	City and Factory	Personal	Laboratory only
	%	%	%	%	%	%
F	56.0	2.0	.7	0	1.1	40.1
I	52.6	23.7	5.8	.5	2.1	15.3
A	45.3	8.4	1.5	.2	1.4	43.1
B	43.9	8.0	8.0	2.7	1.6	35.7
J	42.7	14.4	8.4	.6	1.3	32.5
D	41.8	6.1	2.0	.3	.7	49.1
H	39.4	5.0	7.6	.4	3.7	42.9
L	38.7	9.6	6.9	.7	1.9	42.2
S	36.6	11.9	7.9	0	0	43.6
E	35.9	5.4	2.7	2.7	0	55.5
N	35.1	9.1	5.1	1.0	.4	49.3
O	34.4	7.6	7.0	3.4	.6	47.0
P	34.2	5.8	4.1	0	.4	55.5
G	32.5	12.3	4.6	4.3	.9	45.4
M	28.1	4.0	10.9	.2	.2	56.7
C	27.2	14.3	4.5	.3	2.1	51.6
K	24.4	9.4	6.3	1.8	.2	57.9
Q	23.8	10.3	9.8	1.0	.7	54.4
R	20.6	1.5	1.5	0	0	76.3
Median	35.9	8.4	5.8	.6	.7	47.0
Average	36.5	8.9	5.4	1.1	1.0	47.1
Highest	56.0	14.4	10.9	4.3	3.7	76.3
Lowest	20.6	1.5	.5	0	0	15.3
Average Deviation	7.2	3.7	2.5	.9	.7	8.2

in the high school science repertoire. Every book with a greater number of distinctive experiments is counterbalanced by one with less. The great outdoors is especially neglected; the students of general science, it seems, are to be protected from the sun, the wind, and contact with moist soil.

And where shall supplies be obtained? Even though the home and the store be credited with everything they could possibly furnish, still practically half of what is used by general science students must come, according to directions given, from the specialized equipment of the laboratory. The home and its environments can supply only a little over one-third of what is called for; the store one-twelfth, the forests and fields one-sixteenth.

V. *In which I summon some correlations as witnesses.*

A common sense interpretation of these percentages would suggest that a text or manual which included a large amount of experimental chemistry and physics would borrow equipment most heavily from the standard laboratory. But the physics of general science could be taught by using the familiar things of the home and store, and it might be argued that it is presented that way in general science texts. We might also feel that a book full of unique experiments would draw supplies principally from the home, the store, and the fields; but some one would surely point out the possibilities of new, wholly unusual experiments carried out with standard laboratory supplies. The modern student of educational problems uses correlations to settle such arguments. A coefficient of correlation lies between +1.0 and −1.0. If, in all the general science texts and manuals the per cent of home supplies called for was high or low in exact correspondence with the amount of physics offered, the correlation would be +1.0; if the per cents were in exact opposition—much physics, few home supplies—the coefficient of correlation would be −1.0. Exact correspondence is not to be expected; but whether such a tendency is strong or weak will be clearly indicated.

The correlations[2] between the subjects of experiments and the materials called for are found to be as follows:

Physics and laboratory supplies	+.541
Chemistry and laboratory supplies	+.057
Unique experiments and laboratory supplies	−.358
Physics and home supplies	−.226
Chemistry and home supplies	+.182
Unique experiments and home supplies	+.436

[2]Computed by Pearson's formula. See Alexander, Carter; *School Statistics and Publicity*, page 185; Rugg, Harold O.; Statistical *Methods Applied to Education*, page 275.

Correlations, either plus or minus, of .300 or less are very weak and show that the two things compared have no particular influence upon each other.

We see from these coefficients of correlation that physics in general science is mostly to blame for the large use of standard laboratory equipment. As expected, the books which contain the greatest number of unique experiments call upon the home most and the laboratory least. We might feel sure that these facts were true; the coefficients confirm our belief. There are many other interesting relationships that might be shown by further statistical study of these tables.

VI. *In which I am put to flight.*

In all this study I was getting ready to show that experimental general science introduces a child to everyday science in unique, distinctive, and appropriate ways; that general science manuals are not merely juvenile physics, chemistry, and biology laboratory directions. *I have failed to prove my point!* And my pride is hurt! My apple of joy has a worm in it! Is it possible that there are only a certain number of experiments with which to teach! Have the high school science teachers collected all of them in their box, and if general science teachers are to play school, must they steal from them? Is Nature to be revealed only in terms of sonometers, hydrometers, calorimeters, Erlenmeyer flasks, and Liebig condensers? Must the general science teacher be forced to depend upon the good nature and accommodation of a physics or chemistry instructor for the success of his experimental work? Can he offer from one-third to one-half of this teacher's experiments to his own youngsters, and still keep the peace?

VII. *In which I plead for mercy.*

Who will consider the problems of the teacher in a small school who is trying to handle several sciences, and who has equipped a tiny laboratory for the use of his advanced courses—physics, chemistry, or biology? What of the teacher of general science in the seventh or eighth grade in a grammar school where there is no laboratory from which to borrow? Who remembers that for one teacher having a liberal amount to spend, there are a dozen who must improvise; who have no other source than the home and the town for materials, if general science is to be taught at all? How shall these handle the experimental part of a book in which from one-half to three-fourths of the apparatus called for can only be secured from a physics and chemistry laboratory?

Some point out that every piece of chemical and physical apparatus has its counterpart in a household utensil. To this I chant, "Amen." Household articles were first invented by men; the chemist and the physicist have developed substitutes merely to secure greater accuracy and visibility. But which of the two, teacher or author, should exercise the ingenuity necessary in selecting material for science experiments from the home, the town, the store, the fields, and the forest? Upon which of them lies the first responsibility of making general science a vigorous, distinctive experimental science, free from plagiarism and imitation, recognizing science as limitless and inexhaustible, not already fully surveyed and fenced? Are there such fierce Indians in the woods, that authors dare not venture beyond the stockades already built?

We hear much of the poor training of general science teachers. The unpopularity of the subject in many quarters is laid upon their inefficiency. But let us talk about the poor training of authors of general science texts who, with certain notable exceptions, have turned out such stereotyped books from an experimental standpoint. Many of these texts are splendid as to selection and organization of subject matter; the teacher can talk and the pupils can read; *but they cannot do the experiments!* Whatever originality is to be found with the first-hand investigations of everyday science by pupils is due largely to certain gifted teachers, of singular alertness, who have offered unique and practical courses in spite of the texts in their hands.

VIII. *In which I bring the discussion to clothes.*

Perhaps a book in which one hundred per cent of the material for experiment could be brought from the home, the store, the forest and field is too radical to be written. It may be impossible to compile a manual that anticipates not a single one of the recognized biology, chemistry, and physics experiments. But this problem of general science—finding something for boys and girls to do, and a distinctive way to do it—must receive earnest consideration if one of the most serious criticisms of the subject is to be sincerely met. Truly, general science can, and should, be clothed in its own habiliments. It is a privilege granted to all things that grow and show strength. Perhaps this will illustrate the point: (*Dactylic tetrameter, please! Watch your step!*)

Tim was the baby—last of the collection;
And as he was growing, upon him descended
The clothes of his brothers, cast-off, cleaned, and mended;
Bill's shirt, Joseph's socks, daddy's ties, frayed, but splendid.
Not even his trousers were his. It offended
His soul, and he pondered in painful reflection.

ORGANIZATION OF GENERAL SCIENCE IN THE SEVENTH AND EIGHTH GRADES OF THE JUNIOR HIGH SCHOOL AND THE NINTH GRADE OF THE FOUR YEAR HIGH SCHOOL.

By Ira C. Davis,

University High School, Madison, Wis.

The statement has been made frequently that general science is unorganized; that it is a piecemeal mixture of science. If we consider the subject matter presented in ten of the most recent textbooks it is found that there is about seventy per cent of agreement in this subject matter. This per cent of agreement in general science is greater than in many other courses of study.

A large number of science teachers follow the exact order of the textbook. As far as actual teaching is concerned, the subject matter presented agrees almost wholly with the textbook. These textbooks are organized largely according to the opinions of the authors. Many of these authors have made intensive studies of the subject matter that should be presented to boys and girls. Again, some teachers have attempted to outline their own courses of study with the usual result that undue emphasis is placed upon some special phase of the subject matter.

If a summary is made of the different attempts to organize courses of study, it is found possible to group these attempts:

1. Courses of study as developed in textbooks.
2. Special courses usually placing emphasis upon some special phase of science.
3. Courses made for some particular locality.
4. Separate courses made for boys and girls.
5. Courses made by selecting the most important units in each branch of science and attempting to group them into some coherent form.
6. Courses built upon the interests of the pupils.
7 Courses combining civics and science into our so-called courses in civic science.

In the organization of subject matter, the first factors to be considered are the aims to be developed in the teaching of general science. If concensus of general science teachers is taken, it is found that the most important aim is to acquaint the pupils with their environment. This should be followed by stressing the necessity of the pupils gaining a large number of valuable scientific facts. Personally, I believe the most important aim is to develop the scientific method of solving a problem. In what other subject does a pupil have an opportunity to learn how to use the scientific method? The scientific method includes the acquisition of a method of working, a willingness to suspend judgment until the problem has been thoroughly mastered, and the ability to draw some definite conclusions from the facts and data presented.

Teachers often make the statement that pupils in general science are unable to use the scientific method; that it is a waste of time to attempt to develop the method. If pupils in general science could use the scientific method at the beginning of the course, there would be no object in offering such a course. Pupils are unable to use the scientific method at the beginning of the course. They can, however, learn how to use it. Teachers often forget that it is their duty to teach pupils something, not to find out what they don't know.

In the organization of a course of study in general science the most important factor to determine is: What is the average environment of a boy or girl? Follow this by the development of a plan which will train the pupils in the best methods of studying and understanding this environment. How far have our present courses in general science fulfilled these aims? While there has been considerable agreement in subject matter, there has been very little agreement in the best methods of teaching this subject matter, with the inevitable result that we have very few teachers trained to teach general science.

The normal activities of boys and girls center around a few simple things. They are constantly in contact with simple scientific facts and principles. While the activities of certain individuals may vary to a considerable degree, by and large, all boys and girls are interested in practically the same things. It is possible to group all of these activities:

1. Eating, or foods.
2. Play and entertainment.
3. Sleep.
4. Reading.
5. Talking.
6. Working, including going to school.
7. Keeping warm or cool.
8. Clothing themselves.
9. Moving from one place to another.

What science can best explain these activities to boys and girls?

In organizing these activities into a coherent, progressively difficult, course, several problems must be considered:

1. The maturity of the pupils.
2. The length of the class period or the length of the course.
3. The training of the average tracher.
4. The equipment found in the average school.
5. The training of the pupils in science.
6. The number of pupils taking advanced courses in science.
7. The aims to be developed in teaching.
8. The training in the ability of the pupils to solve problems of increasing difficulty, or the ability of the pupils to use the information they have gained in attacking new problems.

The most important problem to be considered is the teacher. We cannot plan our courses for the exceptional teacher. These teachers can take care of themselves but unfortunately this number is far too small. The courses must be organized so thoroughly that an ordinary teacher can teach with the equipment found in the average school. This does not imply in the least that allowance is not to be made for improvement in equipment and progress in teaching, but it does imply that if our ordinary teacher is to achieve any success in the teaching of general science, the organization of the course must be left to our exceptional teachers. If our exceptional teachers cannot organize the subject matter for a course in general science, how can we expect the ordinary teacher to do it? This ought to be argument enough against the statement that all of our teachers ought to be encouraged to organize their courses of study in general science.

Pupils in the seventh, eighth, and ninth grades do not differ to any large degree in their ability to understand science. The pupils in the lower grades make slower progress at the beginning, largely due to their inability to express themselves thoroughly in written work. Pupils in general science can follow directions for experimental work practically as well as pupils in advanced courses in science. They have difficulty in drawing conclusions in many instances, but pupils in all science classes have the same difficulty. In many instances the pupils in the lower grades are better experimenters. Their preconceived notions about certain phenomena are not so well fixed. If new methods are sought for proving certain principles, their suggestions or solutions are just as feasible as are the suggestions of the pupils in more advanced courses in science. The argument against general science that it is too difficult for the pupils of the seventh, eighth or ninth grades is not proven by the experience of teachers working with pupils of these grades.

The equipment for general science is far from being adequate. While many schools have a fairly good supply of demonstration apparatus, they are woefully lacking in sufficient apparatus for the pupils to work with in the laboratory. The apparatus needed is not expensive, and with careful planning on the part of the teacher it ought to be possible for the schools to secure enough apparatus for the pupils to work with in the laboratory. Several sections or classes can use the same material. In most schools, adequate apparatus for one class is all that is needed.

Most schools offering general science have it a full year in the ninth grade, while others offer it only a part of the year. In schools with a junior high school organization general science is offered either one or two years from three to five days a week. The first year of the high school is crowded with required subjects. Adding general science to this list still further complicates the problem. If a high school can be organized on the six-three-three plan, general science can best be placed in the seventh and eighth grades. If the junior high school is a field of exploration, then it is not unreasonable to ask that general science be required of practically all of the pupils. A pupil does not know whether or not he likes science until he has had an opportunity to study science. To accomplish this plan it is necessary to adopt the hour period for all classes during the day. The old forty to forty-five minute period is too short, while a double laboratory period is not needed for laboratory work in general science.

It is not the most important aim in general science to prepare pupils for advanced courses in science. The pupils have had general training in mathematics, English, history, etc. They are prepared to enter the specialized courses in those fields when they begin high school. This is not the condition in science. Our teachers in the advanced courses in science complain that general science deadens the interest in these sciences. Teachers of English and mathematics do not attempt to belittle the work done by the pupils in these subjects simply because the work was not done in high school. The teachers of these subjects have adapted their courses to the needs and abilities of the pupils as they find them. Many of our science teachers seem to have the impression that interest in any subject depends upon the ignorance of the pupils when they begin the subject. The pupils should have a general foundation in science and this can only be secured by giving a thorough course in general science.

If all our pupils were required to take all of the sciences as pupils are required to do in English and provided all of them remained in school, then it would be a simple matter to teach certain fundamental units of science each year. Many pupils will leave school before they reach the tenth grade; a few more will not take advanced courses in science; while many of those that do remain will take at least one advanced course in science. It is not possible to differentiate enough in our courses in general science to meet all of these needs as found in most of our schools.

Statistics show that for every one hundred pupils in the fifth grade only sixty-three finish the eighth grade, thirty-seven enter the ninth grade, and twelve finish high school. Of the one hundred pupils in the fifth grade, nearly three-fourths of them have left school before they have completed the ninth grade. Of the twenty-five pupils remaining in high school after the ninth grade, not more than ten will take any courses in the advanced sciences. While statistics show that out of every one hundred pupils in the fifth grade ten will take advanced courses in science, no one knows which these ten will be. Is it possible that our science teachers will oppose the opportunity of our boys and girls studying science in the seventh, eighth, and ninth grades when statistics prove that only one-fourth of the pupils will remain in school after that time?

The aims of general science should be developed in correlation with the subject matter. Is there a gradual increase in difficulty in the subject matter? Are pupils able to solve more complex problems as they progress in their work? Are pupils given opportunities to use the information they already possess in attacking new problems, or in other words, are the pupils given plenty of opportunities to think? The real test of general science is the ability of the pupils to formulate methods of studying the scientific problems in their environment and their ability to make use of the solutions of these problems in the better understanding of themselves.

In organizing the activities of boys and girls into teaching units it is found that the list of these units is not large; neither is there a great deal of difference in the science to be taught boys and girls in the same or different localities. The principles remain practically the same while some of the applications may differ.

Probably the most important activity of a boy or girl is eating. This requires a thorough study of foods. What should pupils know about their foods? In the study of foods pupils should know about the sources of their foods, real food values, digestion, etc. It also includes a study of water, air, heat, light, and health. The study of foods then would include a study of animals, plants, air, water, heat, light, and health.

In play or entertainment, the main sources of amusement come from toys of some kind. These can be grouped into toys built upon the principles of machines, chemical sets, electrical toys, magic lanterns, radio, or some sort of a musical instrument.

In plays, then, machines, simple chemistry, electricity, light and sound are some important problems to be considered.

In sleeping, breathing pure air is important. The necessity of rest is also important. In sleep, breathing, pure air, ventilation and health are the most important topics. In reading, the principles of the reflection and refraction of light are important. The eye and the camera are compared. The main topic then is light. In talking, the principles of sound are important. The production of sound, musical instruments, echoes, etc., are commonly included in the study of sound.

In working, the activities of boys and girls will differ. A girl can apply science in washing dishes or any other phase of housework, while the same will hold true for boys in their different phases of work. Practically all of the different phases of science will enter into the work performed by boys and girls.

In keeping themselves warm or cold, a study would be made of textiles, climate, heat, light, building of houses, etc., while clothing themselves would be included in the study of the same topics. In moving around, the automobile, airplane, bicycle etc., would be included. Practically all of these would require a study of machines.

The units that are fundamental to the teaching of general science must be arranged in some coherent form. In doing this it is necessary to consider:

1. The possibility of demonstration of or experimentation with the subject matter.
2. The seasons.
3. The difficulties to be encountered in each unit.
4. The possibility of the use of projects.

If we take these factors into consideration, the best possible order to arranges these units is the following:

1. Air	8. Simple chemistry
2. Water	9. Soils
3. Heat	10. Plants
4. Light	11. Animals
5. Sound	12. Clothing
6. Electricity	13. Foods
7. Energy and machines	14. Modern scientific development

No attempt has been made to differentiate the different sciences in this organization; neither has any special emphasis been placed upon any branch of science. In teaching air, for example, no attempt is made to differentiate the physical and biological sciences. A study of health should be emphasized constantly in the teaching of all of the units. The units are not

equally important, yet undue emphasis should not be given any unit to the exclusion of the others. The main units should be broken up into smaller teaching units. Each unit should contribute to the solution of the main problem and in many instances to the solutions of problems that are to follow. These smaller units should be made to correlate with the real problems the boys and girls meet outside of school. When necessary, different applications can be made for boys and girls, and some provision may be made for the differences in the abilities of the different pupils.

What method of teaching best fulfills the aims to be developed in general science? The experiment-problem-project method fulfills all of the aims of general science. In our experiment the directions are written for the pupils. In the problem the pupils write their own directions. At the beginning the problems are simple, usually containing only one factor. The problems gradually become more difficult. A project is a group of related problems. But again, the pupils organize their own methods of procedure. We cannot expect pupils to work a project at the beginning of a course in general science. Pupils must learn how to use the scientific method before they can work projects with any satisfactory results.

In teaching general science we must, at the beginning, teach the pupils how to experiment. After the pupils have performed an experiment according to directions, ask them to solve problems similar to the experiment. Encourage pupils to offer suggestions for the solutions of these problems. In many instances the best solutions of these problems can be demonstrated to the other members of the group. By combining judiciously experimentation by the pupils, demonstration by the teacher, and the solutions of problems by the pupils, progress can be made in the development of the scientific method. The reading of books, class discussions, applications of principles demonstrated, all enter into the procedure.

Many problems solved leads to the solution of many more problems. New problems are constantly arising out of such a class procedure. A class procedure like this gradually leads up to more complicated problems and projects. These projects should be the culmination of the year's work. The pupils have had an opportunity to select their projects wisely. These projects should be something the pupils are interested in and something they think is worth while.

The pupils must organize their own methods of procedure; they must devise their own methods of attack for the many problems to be solved, and they must organize their results into some coherent form, or arrive at some definite conclusion. In addition to this each pupil must demonstrate his results to the other members of the group. In this way pupils take part in the solution of many projects. They have an opportunity to see many different methods of procedure with the consequent differences in types of attack. This varied experience gained by pupils in the working out of projects in school ought to prepare them for the solution of projects after they leave school.

The method advocated for the teaching of general science can be developed by all of our teachers. It does not need a new set of equipment or a new environment. It can be placed in operation in all of our schools with certain slight modifications. It needs a teacher with an eagerness to attempt to train pupils in the scientific method of attack. The acquisition of facts and the ability to begin to use the scientific method makes it possible for boys and girls to better understand and appreciate their environment.

SOUTHERN CALIFORNIA MATHEMATICS AND SCIENCE ASSOCIATION—MINUTES OF THE GENERAL MEETING.

The Association held an all-day session at Los Angeles High school. The general meeting of the morning was called to order at 9:30 by President Weatherby and was devoted to addresses and discussion of the problems and advantages in using motion pictures in science teaching. There were interesting talks by Miss Loretta Clark and Mr. Walter Lesh and Mr. Edw. Symonds, and demonstrations by Mr. J. H. Doebler; Briefer talks by Messrs. Clifton, Westcott, Painter and Moore and Misses Meredith and Miss Reed; music by the L. A. high music department.

Luncheon in the high school cafeteria was followed by the special section meetings as scheduled on the enclosed program, with the addition of a talk on "Wood-Destroying Organisms," by Mr. S. Rittenhouse, of U. S. C. Altogether it was a wonderful day, and the meetings were very well attended.

Miss Clark offered to lend some of the Los Angeles school films to teachers of outside schools, especially recommending material at hand for B9 and General Science and Biology. The projection Room at 212 West 11th was always open, she said, and would be glad to run any film the teachers might wish to see. Films especially praised were "Thro Life's Windows," "Ray of Light," "The Flame of Life," "Beyond the Microscope," "Care of the Teeth," "Life History of the Mosquito," ditto "The Fly," "Lakes of Fire," etc.

Mr. Symonds asked that teachers should tell them what sort of films were needed; so that the makers might work out methods of demonstrating the subject desired, as films were far superior to laboratory demonstrations in many respects.

Reading of the minutes was postponed to a later date.

GRACE M. R. ABBOT, Secretary-Treasurer.

A SIMPLE SPECTRO-COLORIMETER.

By G. A. Shook and George B. Sargent,
Wheaton College, Norton, Mass.

While no novel feature is claimed for this particular piece of apparatus the parts are so designed that it may be readily constructed without many difficult adjustments.

As the most important part of any photometric apparatus is the arrangement for bringing the two fields together, no attempt is here made to simplify this part of the instrument. In this respect it compares favorably with the more expensive instruments.

It is intended primarily for student use and was developed to be used for experiments that might replace some of the more classical ones that are now in our college courses.

The authors see no reason why such important things as experiments dealing with the determination of transmission factors, reflection factors, glare, etc., might not be substituted for some of the standard ones that held the center of the stage before such factors entered into the lighting problem or the question of interior decoration.

Even an approximate method for determining the transmission factor or reflection factor is probably as useful as some of the methods that are still used to determine the index of refraction.

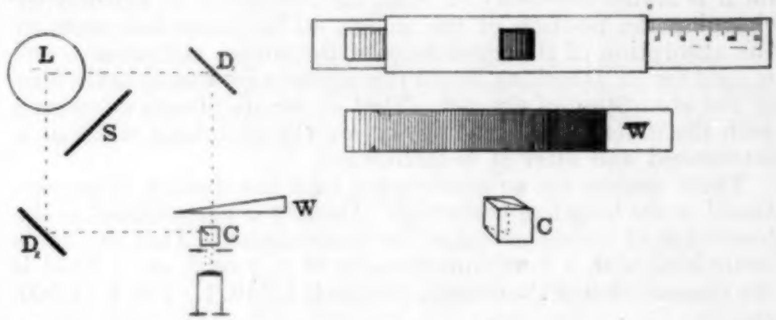


FIGURE 1. *Optical system of the Spectro-Colorimeter.*

The arrangement of the various parts of the spectro-colorimeter are shown in Figure 1. The photometric cube, C, consists of two right angle prisms cemented together as shown. One-half of the hypotenuse face of one is silvered. The cube is one-half inch on each side and the diaphragm in front of it is three-eights inch in diameter. This type of cube has been found very satisfactory for all ordinary work and the authors use this cube on four different kinds of photometric apparatus. The field of view is examined by means of a simple magnifying lens three-fourths inch in diameter and one and one-half inch focus. It is provided with a one-eighth inch stop placed two inches from the lens.

The diffusing screens D_1 and D_2 are simply pieces of tin about two inches square upon which a coat of magnesium oxide has been deposited. The screen S is so placed as to exclude light from the cube. Illumination is furnished by means of a 35 watt concentrated filament projection lamp. As the diffusing screens are large there is no difficulty whatever in obtaining a uniform photometric field and with this arrangement a lateral movement of the eye will not cause any change in the relative brightness of the two fields. The lamp should be placed a little nearer D_1 than D_2 so that D_1 is always somewhat brighter than D_2.

Light from the lamp L is reflected from D_1 and then passes through one half the cube C. From the same lamp light is also reflected from D_2 and again reflected from the silvered half of the cube to the eye lens. The brightness of the light from D_1 is varied by means of a neutral tint wedge. It is mounted in a piece of brass tubing eight inches long and the inside dimensions are one-half inch by one-half inch. This tube is provided with a centimeter scale as shown, and it works in a tube which is just the next size larger. The use of such telescope tubing greatly simplifies the construction of pieces of apparatus of this description. It is not necessary that the zero of the scale coincides with the small end of the wedge (that is with the part of the wedge which has the least absorption as the "wedge" really consists of a photographic film cemented between two pieces of glass) for it is always necessary to bring the two beams to equality by changing the position of the wedge. This takes into account the absorption of the glass sides of the wedge and when a cell is used for an absorbing liquid this initial adjustment takes care of the absorption of the cell. That is, we are always concerned with the difference in reading; before the absorbing material is introduced and after it is introduced.

These wedges are so constructed that the density is proportional to the length of the wedge. Density is here defined as the logarithm of the reciprocal of the transmission. They are made 10cm long with a maximum density of 1, 2 or 3, etc. That is the transmission of the densest portion is 1 /10, 1 /100, 1 /1,000, etc.

If the reading of the scale, attached to the containing tube, is in centimeters then the fraction of the light transmitted, T, at any point is given by the equation,

$$\log \frac{1}{T} = .1R \qquad (1)$$

for a wedge of density 1. If the density of the wedge is 2, then the constant is 0.2 and in general we may write

$$\log \frac{1}{T} = nR$$

If the brightness of the incident light is B_0 and that of the light transmitted through the wedge B then

$$\log \frac{B_o}{B} = nR \qquad (1)$$

The relative error of the wedge is the same for all parts of the scale, for upon differentiating (1) we have

$$\frac{dB}{B} = -\,ndR$$

That is, at any part of the scale, an error of say 0.1 mm will cause the same relative error.

TRANSMISSION FACTORS.

Suppose the wedge is adjusted until a photometric balance obtains and let the reading of the scale be R_o. The light transmitted by the wedge is equal to the light reflected from the surface D_2, whence

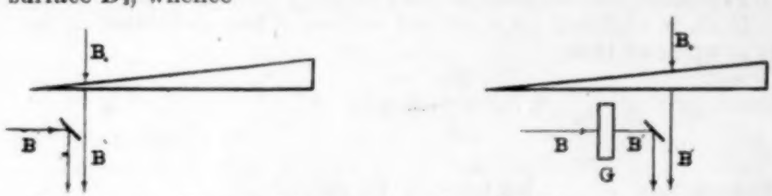


FIGURE 2. *Transmission factor of an absorbing glass G.*

$$\log \frac{B_o}{B} = nR_o$$

If now in the path of the beam from D_2 a glass G of transmission T, is interposed it will be necessary to advance the wedge as indicated in Figure 2 in order to obtain a balance. Let the reading of the scale now be R_T then

$$\log \frac{B_o}{B'} = nR_T$$

$$\therefore \log \frac{B}{B'} = \log \frac{1}{T} n\,(R_T - R_o)$$

When such an instrument as this is provided with wedges of different densities the range is considerably increased. For example, in determining the transmission factor of a glass of low transmission, say from 1/1,000 to 1/100, a wedge of density 3 would be used, but if the transmission were 1/2, the scale would not be open enough. In this case a density 1 wedge could be used. When each wedge is separately mounted in a tube provided with a scale, as shown, it is only the work of a moment to substitute one for the other.

REFLECTION FACTORS.

The following method gives only approximate results and must be confined to diffusing surfaces but it gives the student some idea as to how such factors may be determined. Let the

reflection factor for D_2 be ρ_1, the brightness of the light upon D_2 be B and the brightness of the reflected light B_1. Then $B_1 = \rho_1 B$ and if the reading of the scale is R_1 when a balance obtains, we may write

$$\log \frac{B_0}{B_1} = \log \frac{B_0}{\rho_1 B} = nR_1$$

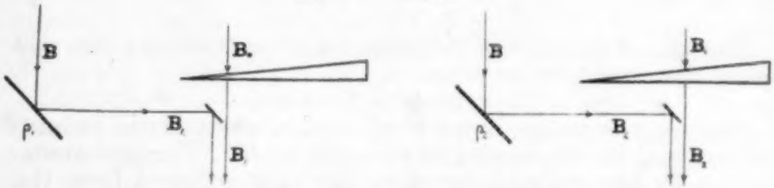


FIGURE 3. *Conditions for determining reflection factors.*

If D_2 is replaced by a second surface whose reflection factor is ρ_2 we have that

$$\log \frac{B_0}{\rho_2 B} = nR_2$$

whence
$$\log \frac{\rho_1}{\rho_2} = n(R_2 - R_1)$$

When D_2 is a magnesium carbonate block or a surface of magnesium oxide ρ_1 may be taken as 1.

CONCENTRATION OF A COLORED SOLUTION.

Consider a unit thickness of some absorbing material such as a piece of glass. Let the intensity of the light incident upon it be I_0 and the transmission factor be a, then the light transmitted by this unit thickness will be

$$I_1 = I_0 a$$

If the light I_1 passes through an identical piece of glass the intensity will be

$$I_2 = I_1 a = I_0 a^2, \text{ etc.}$$

FIGURE 4. *Illustration of Beer's law when the transmission factor is 1/2.*

For a thickness l we would manifestly have

$$l_o = I_0 a^l \qquad (2)$$

Now consider a colored solution of unit concentration (i. e. 1 g of solute in 100cc of solvent) if the transmission factor is b the transmitted light will have the value

$$I_1 = I_0 b$$

If the concentration is now doubled i. e., if twice the number of absorbing molecules are introduced into the same space then the light transmitted becomes

$$I_2 = I_0 b^2$$

and for a concentration of 3

$$I_3 = I_0 b^3$$

For a concentration *c* therefore

$$I_c = I_0 b^c$$

As in the above case the light transmitted through unit thickness may be expressed in the form

$$I_1 = I_0 a$$

or

$$I_c = I_0 a$$

whence

$$a = b^c$$

That is, in dealing with a solution we may express the transmission factor *a* as a function of the concentration, in which case it becomes b^c. Equation (2) now takes the more general form

$$I_{lc} = I_0 b^{lc}$$

or simply

$$I = I_0 b^{lc} \qquad (3)$$

which is Beer's law.

Equation (3) may also be written in the form

$$\log \frac{I_0}{I} = ck \qquad (4)$$

where k is a positive constant.

Equation (4) may be applied to the instrument described above for the determination of the concentration of a colored solution.

As the light transmitted by the solution will not be the same color as the comparison light it is necessary to use a color screen before the eye piece. Assuming then that we are using light of one color the method of procedure is somewhat as follows:

The cell, which is to contain the liquid to be tested, is placed at *G* Fig. 2, filled with the solvent to be used and a balance is obtained in the usual manner. Let this reading be R_0. We may now write

$$\log \frac{B_0}{B'} = nR_0$$

The cell is now filled with the solution to be tested and a second balance is obtained. Let this reading be R_c.

The Brightness B' is now reduced to some value B'', whence

$$\log \frac{B_0}{B''} = nR_c$$

$$\therefore \quad \log \frac{B'}{B''} = n(R_c - R_0)$$

But from Beer's law. (4)

$$\log \frac{B'}{B''} = ck = n(R_e - R_0)$$

which may be written

$$c = A\,(R_c - R_0)$$

The constant A depends only upon the solution and the color or wave-length used. It may be determined from a known concentration. A better value is of course obtained from a number of concentrations.

In this type of spectro-colorimeter the concentration is strictly proportional to the scale reading. The advantage it has over other colorimeters is that no standard solution is required. Since a color screen must be used to render both fields the same hue a considerable amount of light is lost but this disadvantage is offset by the increased accuracy which will result if the proper color is used. For instance in the case of a blue solution the absorption, for a given concentration, is greatest for the red part of the spectrum, while for a red solution the absorption is greatest for the blue part of the spectrum.

Table 1 gives the transmission factors of a blue solution for different color screens and Table 2 gives the factors for a red solution.

TABLE 1. *4% solution of copper sulphate.*

Color of screen	Dark red	Light red	Yellow	Green	Blue green
$R_e - R_0$	8.47	1.89	0.92	0.30	0.16
T	0.14	0.65	0.81	0.93	0.96

TABLE 2. *4% solution of cobalt chloride.*

Color of screen	Dark red	Light red	Yellow	Green	Blue green
$R_e - R_0$	0.56	0.79	1.73	5.61	7.24
T	0.88	0.83	0.67	0.27	0.19

It is clear from this data that the dark red filter should be used for the copper sulphate while the blue green filter should be used for the cobalt chloride.

SALMON PLANTING.

The Pacific salmon's love of home may be used to naturalize this valuable food fish in distant foreign waters. Dr. Meyer Gurewitz of the Bureau of Science of Palestine has hopes of transplanting salmon from our Pacific Coast to the Mediterranean Sea. Salmon come back to spawn in the same stream in which they were hatched. By transplanting the eggs, however, this homing instinct may be used to establish the fish far from home.

NEW METHOD OF BIRD STUDY.

By William I. Lyon,

124 Washington Street, Waukegan, Ill.

Do you know the fascination of trapping and banding wild birds? Have you held a bird in your hands, examined him carefully, released him, and then found that, instead of being frightened away, he comes back to your traps again and again; sometimes the same day, the same week; perhaps he reports to you nearly every day all summer; yes, and some of them year after year.

Professional or amateur ornithologist, you may, by this method, handle hundreds of birds in a year, study the bird, his habits, his mates, and even keep a record of his children, or grandchildren. By this method you may secure new kinds of facts, that were formerly so very difficult to obtain. And this is no guess work, for each bird is identified by the number on the small aluminum band, which you have attached to his leg when first taken.

A trapping and banding station benefits and increases the number of birds. As success requires that the locality be freed of the enemies of birds; that food and shelter be provided, the locality becomes, in fact, a bird sanctuary. Many officers of Audubon Societies are recommending this method, not only as the best means of increasing popular interest in birds, but because it directly benefits and increases the number of birds.

This method of bird study has been adopted by the United States Biological Survey (Washington, D. C.), and special permits for bird banding are issued to those who will volunteer to place the bands which are furnished by the survey. These permits are issued only to persons over eighteen years of age who have sufficient experience and knowledge of birds to carry on the work with scientific accuracy.

The bands have a numeral consisting of sometimes, as high as six figures, also the legend "Biol. Surv." on the outside of the band, and on the inside of the band is, "Wash., D. C." The bands come in eight different sizes which makes them adaptable to any size birds. The band, when placed, individualizes that bird for life, and is recorded in Washington. Whenever a report comes in referring to his number, it is duly recorded on his card. In many cases birds have been reported two, three, and a few, four and five times and even more, during their lives. Eventually, these reports will aid in solving the many questions about the life histories of birds.

There is one special mystery of today, and that is, where does the chimney swift spend its winter? The only known answer, so far, is that there are many swifts in some portions of South America, but nobody has been able to identify our chimney swift among them. Should someone band a chimney swift in the United States and it would be found alive or dead in the Upper Amazon River country, it would immediately establish

a real fact about his life, something scientists are interested in knowing.

Bird banding is producing many new questions to science, also solving some of those that have been difficult, and it is doing it in common, every-day English language, without being loaded up with cumbersome, technical terms which make most of our science impossible to the general public.

There is so much work to be done, so many fields that we need volunteers to help develop, that everyone can be of assistance to us. If they are unable to volunteer to place bands themselves, they can find people, or send in names of people that they think would be willing to take up the work.

There is another field that needs a great deal of publicity and that is, to bring before every person, the importance of examining any dead bird they happen to see. The instructors can be of great service to this work by bringing it before their classes and requesting the students to be on the lookout for a banded bird.

This fact is well illustrated by the following: The secretary of the Inland Bird Banding Association spoke before his local high school on the subject of bird banding. Some students assembled in the hallway the next day and the subject was brought up by one of them, when suddenly one of the boys said, "Gee whiz, I saw a dead bird two days ago under the bushes," and immediately they started out to investigate. One hour later, one of the members of the group presented a band to the secretary for identification. On looking it up it was found to be the band that had been placed on a downy woodpecker. The remains of the bird were so far obliterated that it was impossible to identify it except through the skeleton. On examining the books, it was found that the Downy Woodpecker had been banded just exactly one year before at a point, just about a mile distant from the school. Three or four of the children of the grade schools have found banded birds and returned them, so the publicity has helped in directing returns.

If any instructor wishes to go into the subject further, the Biological Survey will gladly furnish the book "Instructions for Bird Banding." If you know of someone who is a prospect to become a bander in the district, please notify W. I. Lyon, Secretary, 124 Washington Street, Waukegan, Illinois.

Among the incidents that have been developed in handling birds for ten years at Waukegan are the following: That woodpeckers or birds that sleep in the holes of trees, seem to sleep more soundly than the sparrows and finches that roost in the open; that sparrows as a rule are very keen sighted and quick; thrushes are slower sighted; and that birds have as much disposition and character as people. The woodpeckers and nuthatches have been seen on a number of occasions storing up grain in a knothole, the same as the members of the squirrel family. An owl that had been robbed of two sets of eggs attempted to foster some young flickers.

It has also been seen that storms affect the movement of birds. Many other interesting facts are coming out daily, and the object of this article is, to request your help in spreading information and finding more volunteers to take up this very interesting work. We will appreciate any information or efforts that you may give us.

THE EFFECT OF SELECTION ON THE LENGTH OF SPINE IN DAPHNIA LONGISPINA.

By Margaret S. Young,
Hyde Park High School, Chicago.

Genetici, the latest branch of biology, is rapidly taking its place as a first class subject for research. In fact, it is a very desirable field for research, because the ground is practically virgin, and there is plenty of chance to find a line of work which appeals to one. It is also of value as a branch of instruction for high school students at least for third semester work. The mere fundamental principles can readily be understood and simple laboratory work with the breeding of *drosophila* as monohybrid or *dyhybrid*, such as red eyed and white eyed, long winged and short winged is very interesting and profitable. For three years now, I have had a third semester class, choosing this course out of several others, and attacking it with great enthusiasm, and doing excellent work in it. Some specially fine students even tried their hands at a *trihybrid of drosophila* (black purple vestigial) and did very creditable work. Somehow the subject touches on problems, and throws light on many questions, which concern man closely, hence the interest to the young student.

But when students are so interested it behooves the instructor to look to his laurels and keep ahead of his class, hence the following bit of research.

This work was started December 27, 1922, and so far there have been fifteen generations. This paper is therefore, merely preliminary.

The stock of daphnia came originally from a fish fancier and had been kept in the laboratory for about a year before this experiment was begun.

A parthenogenetic female, No. 3027, was selected to start the first (3,028) generation. A brood is produced about every other day. The stock is kept in fingerbowls under greenhouse conditions and temperature. Food and other environmental conditions are kept as nearly uniform as possible. The food consists of a coccus (chlamyda monas) which causes the water to look green. Successive broods are termed A, B and C and broods A, B and C are used as a basis for all mathematical calculations.

From brood A of 3028 (second gen.), an individual was selected to start the minus strain and another to start the plus strain of 3029 (second gen.). The difference in length of spine between the two was not great. The length of body, divided by the

length of spine and called "index" is made the basis of all calculations. The plus or long spine strain will therefore have a smaller index than the minus or short spine strain.

Selection was made from the A brood of ± 3029 (second gen.) for the ± 3030 (third gen.), the indices being respectively 3.3 and 3.4.

In order to have better proof of the hereditary quality of the character the A broods of ± 3030 (third gen.), were measured alive and the five most favorable animals respectively were used to start five plus lines and five minus lines of 3031 (fourth gen.).

Starting with generation 3032 (fifth) selection was made from the B brood of the + strain individual whose + A brood had the smallest average index, largest spine length, for the plus strain of the next generation. Similarly, selection for the minus strain of the next generation was made from the B brood of the − strain individual whose A brood had the largest average index, smallest spine length. Since however the A brood is apt to be small, sometimes only a few individuals, the method was changed so as to average A & B broods of ± strains and select from the ± C broods of the individuals whose average A & B index was most favorable. In each strain the brood used for selection is measured and the five individuals of + C that have the largest spine, (smallest index), are used to start the + strain of the next generation, and similarly the five individuals of − C that have the shortest spine (largest index), are used to start the − strain of the next generation. This method has been used for generations 3,033 (sixth) to date.

The results are shown in the table of Means and Differences, each with their probable errors.

It shows that the least positive results is a difference which is still four times the probable error and two times as great as the difference between the first selected individuals. In one case the difference is twenty times the probable error.

The frequency curves are interesting. They seem to show that whereas at the beginning the difference is often partly due to odd individuals at the extremes, later these are more or less eliminated and the population more even. The mode of the plus curve seems to be moving to the right of that of the minus curve.

Environmental conditions have important bearing on the results and probably explain the fluctuations of the difference. When the food water becomes concentrated, other algae get the upper hand, especially one on which daphnia could not subsist, and in the long strings of which, it became entangled. A sudden rise in temperature such as is caused by the sun shining on the bowls, kills them rapidly. The food must be continually replenished or they do not thrive. The writer has looked for indications that size of brood or size and vigor of animal caused a difference, but has been unable to find any signs of this. The vigorous animal is larger both ± but the length of spine has same relation to body length. All individuals were measured

at about seven days old. One cannot tell exact date of birth unless material is under constant surveillance. The size at same age varies considerably, but not so the index.

The work was done entirely with parthenogenetic females, no males appearing; hence the results are entirely in a pure line.

Whether similar results will continue or whether the difference will persist when selection is discontinued remains to be seen. The full significance of the experiment cannot be gauged in so early and preliminary a stage.

What the causes are which may produce selection in a pure line if such should prove possible in the long run, is still an open question.

A. M. Banta, who has had similar results in his interesting work on "Selections in Cladocera on the Basis of Physiological Character," takes up the question. He was slightly successful in selecting daphnia longispina for its reaction to light. In one line he got a difference 4.05 times the probable error.

Sturtevant, in his work on dichaete fruitflies, was able to select plus and minus strains for number of bristles. Dichaete flies vary more in number of bristles than non-dichaete flies.

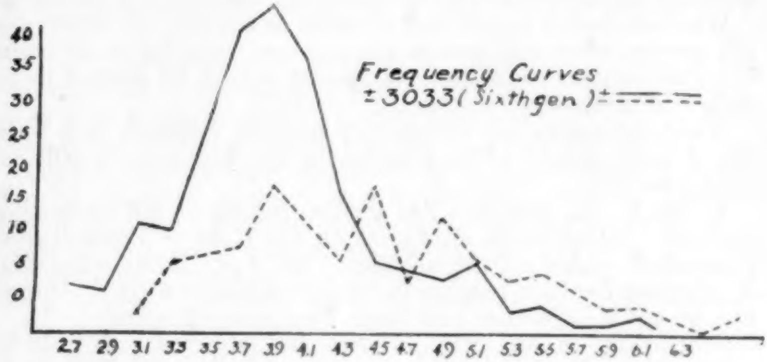
What the causes are that bring about selection in a parthenogenetic and therefore strictly pure line, especially in daphnia where there is only one maturation division with reduction, must be determined by further investigation.

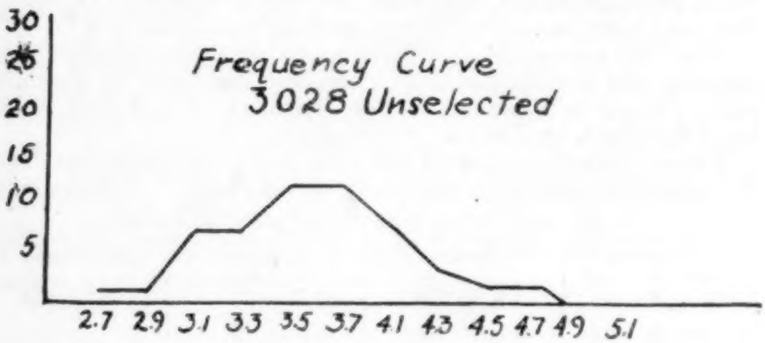
No new factors are added but there are some variations even in a pure line. Selection may make use of these. Or there may

MEANS AND DIFFERENCES WITH PROBABLE ERRORS.

Generation	—Means	+Means	Difference
3028			
3029 (2)	4.6 ±.078	3.7 ±.13	.9 ±.016
3030 (3)	3.76±.046	3.6 ±.04	.11±.062
3031 (4)	4.7 ±.094	4.1 ±.07	.6 ±.011
3032 (5)	4.6 ±.034	4.0 ±.042	.6 ±.05
3033 (6)	4.8 ±.056	3.6 ±.035	1.2 ±.066
3034 (7)	4.2 ±.05	3.98±.051	.22±.055
3035 (8)	3.8 ±.039	3.3 ±.011	.5 ±.05
3036 (9)	3.8 ±.02	3.3 ±.017	.5 ±.025
3037 (10)	3.6 ±.028	3.1 ±.018	.5 ±.02
3038 (11)	3.7 ±.017	3.39±.015	3.1 ±.02
3039 (12)	3.2 ±.021	2.8 ±.027	.4 ±.01
3040 (13)	3.2 ±.022	3.0 ±.113	.2 ±.024
3041 (14)	3.5 ±.01	2.9 ±.01	.6 ±.014
3142 (15)	3.23±.035	2.97±.029	.26±.044

be modifying genes and selection may bring about favorable combinations of these. At any rate, the results show that although not great, there is a persisting and steady difference between the two selected lines.





Formula for Probable Error of Mean

$$= \frac{.6745 \times \text{Standard Deviation}}{\sqrt{\text{number}}} \quad \text{or} \quad \frac{.6745 \times \text{St. Dev}}{\sqrt{n}}$$

Formula for Probable Error of Difference

$$= \sqrt{(\text{P. E. of} +M)^2 + (\text{P. E. of} -M)^2}$$

WHERE SHALL I PLACE THAT DECIMAL POINT?

By Bernard C. Zimmerman,
St. Louis University, St. Louis, Mo.

Mathematics is an exact science. Briggs evidently bore this in mind when he set out to compile his fourteen-place logarithmic table. As evidence that rigid accuracy to the ultimate significant figure has given way to a more reasonable system, I venture a surmise that some of the readers of School Science and Mathematics have never seen a logarithmic table of more than seven places. As a rule they are satisfied with a four-place table, and the slide rule, the equivalent frequently of a three-place table.

Ordinarily the correct placing of the decimal point in the answer of any problem is as important as the answer itself. Difficulties in finding the exact position occur often enough to be a source of vexation, particularly when any but the ordinary arithmetical method for finding the product or quotient has been used.

The writer offers the following method for locating the decimal point in these operations with the assurance that he has found it practical in his classes. Clothed as it necessarily is on paper with explanations that can be more readily given with the aid of a blackboard, the scheme looks perhaps somewhat formidable, but patient perusal will, I trust, dispel the reader's first impression.

By "number of digits" below is meant what is frequently called the order of the number, and sometimes—very misleadingly—the characteristic of the number. Note especially that in a decimal fraction the number of digits is minus one (-1) times the number of zeros between the decimal point and the first significant figure. Thus .000072 has -4 digits, .08 has -1 digit, .204 has 0 digits, and 36.009 has $+2$ digits.

1. *Rule for Multiplication:* The product has the sum of the digits of the factors whenever the first [homogeneous group of]1 significant figure[s] of the product is less than the first [homogeneous group of] significant figure[s] of either factor; in all other cases, one less than the sum.

2. *Rule for Division:* The quotient has the difference between the digits of the dividend and (those of) the divisor whenever the first [homogeneous group of] significant figure[s] of the divisor is greater than the first [homogeneous group of] significant figure[s] of the dividend; in all other cases, the difference plus one.

Expressed in algebraic language, these rules are:

1. If a, b and c represent the number of digits in the multiplicand, multiplier and product respectively—

$$c=a+b \quad \text{if } S_c<S_b \text{ (or } S_a\text{).}$$
$$c=a+b-1 \text{ if } S_c \nless S_b \text{ (or } S_a\text{).}$$

2. If c, b and a represent the number of digits in the dividend, divisor and quotient respectively—

$a = c - b$ if $S_c < S_b$ (or S_a),

$a = c - b + 1$ if $S_c \nless S_b$ (or S_a),

where S_c and S_b stand for the first [homogeneous group of] significant figure[s] in the product and the multiplier respectively or in the dividend and the divisor respectively.

[1]N. B.: In the vast majority of cases it is but necessary to consider the first significant figure of the product and the multiplier, and of the dividend and the divisor respectively. When the first significant figures are the same, we must compare homogeneous groups, i. e., groups having an equal number of digits, irrespective of the position of the decimal point.

Illustrations.

							S_c	S_b
I. a)	400	×	51		=	20400	2	5
	3 [a]	+	$^{-}2$ [b]		=	$^{-}5$ [c]		
b)	20400	÷	51		=	400	2	5
	$^{-}5$ [c]	−	$^{-}2$ [b]		=	3 [a]		
II. a)	9.11	×	842		=	7670.62	7	8
	1	+	$^{-}3$		=	$^{-}4$		
b)	7670.62	÷	842		=	9.11	7	8
	$^{-}4$	−	$^{-}3$		=	1		
III. a)	10	×	90.0		=	900	900	900
	2 [a]	+	$\overline{2}$ [b]	−1	=	$\overline{3}$ [c]		
b)	900	÷	90.0		=	10	900	900
	$^{-}3$ [c]	−	$\overline{2}$ [b]	+1	=	2 [a]		
IV. a)	.005	×	.41		=	.00205	2	4
	−2	+	$\bar{0}$		=	$-\bar{2}$		
b)	.00205	÷	.41		=	.005	2	4
	$-\bar{2}$	−	$\bar{0}$		=	−2		
V. a)	.0005	×	.0015		=	.00000075	7	1
	−3	+	$-\bar{2}$	−1	=	−6		
b)	.00000075	÷	.0015		=	.0005	7	1
	−6	−	$-\bar{2}$	+1	=	−3		
VI. a)	.123	×	13.2		=	1.6236	16	13
	0	+	$\overline{2}$	−1	=	$\overline{1}$		
b)	1.6236	÷	13.2		=	.123	16	13
	$\overline{1}$	−	$\overline{2}$	+1	=	0		

NAVIGATION LIGHTS FOR NIGHT-FLYING AIRPLANES.

Navigation lights on airplanes as well as beacon and boundary lights at landing fields were recommended by Lieutenants H. R. Harris and D. L. Brunner of the U. S. Air Service in an address before the American Society of Mechanical Engineers recently. In addition to these, parachute flares and hand flashlights or similar devices for signalling purposes were advised.

The beacons at terminal landing fields should have a candlepower of at least 250,000, they stated, and illuminated wind cones should be provided at every landing field. With these aids, night flying could be carried on with safety and reliability, the officers declared.

HISTORICAL NOTE ON THE SOLUTION OF EQUATIONS.

By G. A. Miller,
University of Illinois, Urbana, Ill.

It has often been stated that the cubic equation was solved algebraically by Italian mathematicians during the first half of the sixteenth century. This statement is based on the fact that during this period there seems to have been developed the very important formula known as Ferro's formula, Cardan's formula, Tartaglia-Cardan formula, etc. It would appear more accurate to say that the Italian mathematicians whose names are associated with this formula contributed largely toward the algebraic solution of the cubic equation in one unknown but that it took more than two hundred years from the time when the formula appeared in Cardan's noted *Ars Magna* (1545) until it was fully understood and the algebraic solution of this cubic was really completed.

In support of this statement it may be noted that the fundamental fact that Ferro's formula represents not only one root of the cubic equation but the three roots was first exhibited by d'Alembert in 1751. From the fact that Ferro's formula played such a fundamental role in the development of the theory of complex numbers it may be inferred that the complete algebraic solution of the cubic equation as we now understand it was dependent upon the development of the number concept so as to include all the ordinary complex numbers. The wide difference between deriving a formula for the solution of an equation and really understanding this formula is even more clearly exhibited by the history of the quadratic equation in one unknown.

The statement is sometimes made that the ancient Greeks solved the quadratic equation. It is naturally difficult for the thoughtful student to harmonize this statement with the well-known facts that the ancient Greeks did not use negative numbers and that they knew nothing about imaginary numbers. In view of these limitations it appears obvious that they could not have mastered the solution of the quadratic equation as we now understand it. On the other hand, it seems clear that they used in their special solutions rules which are equivalent to our modern formula for the solution of a general quadratic equation in one unknown.

It is a very striking fact in the history of elementary mathematics that formulas for the solution of the quadratic equation were used by the Greeks more than a thousand years before their significance was fully understood. In fact, this period may have extended over more than two thousand years. The wide difference between being in possession of a formula and knowing how to interpret it and use it in a general and thought saving manner is perhaps exhibited nowhere else in the history of elementary mathematics with more clearness than in the history of the quadratic equation in one unknown.

Not only were the ancient Greeks in possession of a formula

which suffices to solve all the quadratic equations in one unknown but in Diophantus we find the use of three such formulas. In fact, these three formulas seem to be much older. When the modern reader of the history of mathematics meets such a formula he is in great danger of assuming that Greek advances along this line extended far beyond their real limits. Some years ago the present writer was led by these formulas and the statements relating thereto as found in general histories of our subject to say things to his own classes which he would now gladly recall if this were possible. He now realizes that the Greeks were far from knowing the complete solution of the quadratic equation as we understand it even if it would be easy to support such a conclusion by references to some of the most recent general histories relating to our subject[1].

One of the most interesting features of the history of mathematics relates to the fact that many of the developments are dependent on others in view of the great interdependence of various parts of our subject. From the fact that the ancient Greeks did not know the factor theorem of elementary algebra, even in its special form as exhibited in the modern theory of the solution of the quadratic equation, one can easily see that they must have missed much that we now regard important in the discussion of the solution of this equation. In particular, they knew nothing about equal roots, nor did they know that a quadratic equation cannot have more than two distinct roots. They knew nothing about the discriminant of such an equation nor did they know that its graph is a parabola. Since they knew nothing about ordinary complex numbers in their general form, they could not have known that every quadratic equation in one unknown has a root. In short the meager development of the number concept in their days is sufficient to establish the fact that their knowledge of the quadratic equation could not have included many of the concepts which we now regard as most interesting in the study of this equation.

The main object of the present note is to emphasize the fact that the complete algebraic solution, as we now understand it, of the general quadratic and of the general cubic equation in one unknown was developed very slowly and by many workers. Similar remarks apply to the general biquadratic equation in one unknown. As each of these solutions had to await the development of the number concept so as to include the numbers of the form $a+bi$, and, in turn, contributed towards this development, we have good reason to assume that it could not have been effected satisfactorily before the close of the eighteenth or the beginning of the nineteenth century. It is true that much earlier dates are usually assigned to these solutions, but it is hoped that the reasonableness of assigning these later dates may appeal to many teachers of our subject. At any rate, it may be of interest to reconsider the question from this point of view.

[1]Cf. D. E. Smith, History of Mathematics, vol. 1. (1923) pp. 126,293.

A STUDY OF THE ILLUSTRATIVE MATERIAL FOUND IN TEN BIOLOGY TEXTS.

By Glenn Stiles,

5715 Kimbark Avenue, Chicago.

The following ten texts were selected for the study of the quantity and quality of their illustrative material, to determine whether a judgment of illustrative material would aid one in selecting a text in biology.

The figures in the column of the table marked "Per cent of Illustration" were determined by computing the space given illustrations in ninths, sixths, thirds, halves, two-thirds, three-fourths, and whole pages, and then finding the per cent of the total page space.

From this computation, it was interesting to note the following points:

1. The size of the pictures most used:

575—One-ninth of a page.
696—One-sixth of a page
542—One-third of a page
360—One-half of a page
86—Two-thirds of a page
94—Three-fourths of a page
169—One page.

2. Those texts using the greatest number of pictures or the greatest number of large pictures were not necessarily the best illustrated.

3. The elementariness of Peabody and Hunt probably accounts for the copious illustration.

4. The highest number of small pictures was used by Bailey and Coleman, portraying plants and animals.

The figures in the column of the table marked "Per cent Good Illustration" were determined in the following way. Good illustrations had to be:

1. Well contrasted in blacks and whites or colors.
2. Clear; i. e., intended points well brought out, and
3. Apt.

While medium and poor illustrations were those:

1. Poor in contrast.
2. Too small for object portrayed, or
3. Gave too much detail.

Explanation of the letters used in the table:

B. & C.—Bailey and Coleman.
N.—Needham.
P. & H.—Peabody and Hunt.
B.—Bigelow.
H.—Hunter.
G.—Gruenberg.
S. R. & B.—Smallwood, Revelly and Bailey.
M.—Moon.

A.—Atwood.
T.—Trafton.

Kind of Text.

G.—General.
A.—Anatomical.
E.—Evolutionary.
C.—Civic.

No.	Name.	Author	Year	Kind	Pages per Text	Grade Placement	No. of Illustrations	Per cent of Illustrations	Per cent Good Illustrations
1	First Course in Biology	B. & C.	1908	G	607	9	757	24.7	79.5
2	General Biology	N	1910	A	511	10 or 11	290	17.7	60.9
3	Elementary Biology	P. & H.	1913	G	170	9	252	50.3	69
4	Introduction to Biology	B	1914	E	414	9	108	7.1	78.9
5	A Civic Biology	H	1914	C	406	10&11	331	20.07	47.1
6	Elementary Biology	G	1919	C	514	10&11	225	18.8	95.9
7	Biology for High School	S. R. & B.	1920	C	550	10&11	424	21.04	60
8	Biology for Beginners	M	1921	A	548	9	152	14.1	59
9	Civic and Economic Biology	A	1922	C	455	10&11	339	41.6	95.6
10	Biology of Home and Community	T	1923	C	605	9	208	9.6	56

Summary.

These general points have been gained from this study:

1. The age of a text can be closely approximated by the type of figure used.

2. The kind of a text can be determined in the same way. The older texts are anatomical, the next evolutionary, and the last have been civic, i. e. economic and social.

3. Civic biologies have, in general, more illustrations than the older general biologies.

4. Graphs, tables and maps appear only in the latter texts.

5. Grade placement has no effect upon the amount of illustrative material used.

6. The more attractive texts have fewer small pictures.

MINING WITH SMOKE.

Mexicans working in a lead mine in Chihuahua have found a new use for cigarettes. The mine consists of a series of caves along the sides and bottoms of which lead and silver ore in paying quantities is found. The miners have noticed that smoke from their cigarettes is sucked through cracks in the rocks at certain points. By drilling in the wake of the smoke, they break through into another cave. This method of tracing the ore has been followed through a series of caves and still the smoke passes out at the end of the last cave discovered, indicating that there are other caves ahead.

THE HAWAIIAN ISLANDS AS A SUMMER RESORT.

By E. L. Moseley,

Normal College, Bowling Green, Ohio.

Going to the tropics for a summer vacation sounds as bad as visiting Greenland in winter. When the noonday sun shines down on Honolulu from directly overhead, so that a pole standing erect casts no shadow, the pavement becomes too hot to hold one's hand on, but the air is continually renewed by wind off the great Pacific Ocean, blowing usually from north of east, or by cool breezes coming down the mountain valleys. Sunstroke is unknown, and the heat is never so oppressive as on the hottest days in the states.

Nowhere else in the United States within such small compass can one see so much that is wonderful or such a variety of beautiful scenery. The Hawaiian Islands are unique in several ways. No other island in the world has such high mountains. The highest in the states east of the Rockies are but little more than half as high as those on Hawaii, the largest of the group. Kilauea on the same island, is said to be the largest continuously active crater in the world, with the possible exception of some which are very difficult of access. The canons of Kauai, another island of the Hawaiian group, rival in color and grandeur the famous canon of Yellowstone River and the Yosemite. On the same island there are sheer cliffs that rise abruptly from the sea to a height of 1,700 feet and from the tops of these cliffs steep slopes ascend to an elevation of 3,000 feet. The rainfall in the mountains of Kauai is the greatest in the world, but the hills to the leeward of these mountains are as dry as those of California. Waterfalls abound on all of the five large islands. There are more than one hundred falls that exceed 500 feet in height and probably a thousand that are higher than Niagara.

In continental United States we have no seaport with such a beautiful background of mountains and residence districts occupying the mountain valleys, nor can any city in the states show at any season such a number and variety of trees, shrubs and vines laden with gorgeous blossoms as are to be seen in summer along the streets of Honolulu. Its aquarium is smaller than the one at the Battery in New York, but in the variety of brightly colored fish we have nothing anywhere in the states to compare with it.

There is probably no city in the states where there is an opportunity to indulge in such a variety of exhilarating outdoor sports

as in Honolulu. It is never too hot—or too cold for games. A baseball team from Leland Stanford University went to the islands last summer on the steamer that took me from San Francisco, affording the California boys a pleasant vacation and a chance to show their skill in the national game, but they lost more games than they won. The Chinese team from Honolulu which made a tour through the states in 1915 and again in 1917 won nearly three-fourths of all the games played. Each of the six army regiments stationed there has its polo team and there are four other polo teams on the islands. On the lawn of Punahou College I watched the first game of cricket I ever saw. The players were Honolulu business men who were born in the British Isles. Golf is more common than polo or cricket. There are four courses on the island of Oahu, where Honolulu is located, and some very good players.

Both tourists and residents at Honolulu are more enthusiastic over surf bathing than any other sport. The more venturesome attempt riding a surf board but it takes a good deal of skill to stand on one while it is racing through the foam at the front of a wave rushing shoreward. It is not so difficult to ride these waves while seated in an outrigger canoe, but paddles must be used vigorously at the right time to keep the canoe at the front of the wave.

An aerial circus under the auspices of the American Legion included a variety of amazing stunts and feats in which twenty-seven airplanes participated without any accident, except that one fell into the water. A dummy ship was bombarded from the air with machine guns and torpedoes. Men standing on surf boards were pulled through the water by hydroplanes until the speed compelled them to relinquish their hold on the rope. Most interesting was the altitude race, when the aerial monsters, looking like tiny birds, would vanish and reappear as clouds would pass under them. This circus, given on a Saturday, when the people have a half holiday, was at Luke Field, the aviation grounds of the army and navy. This is on an island in Pearl Harbor, our great naval station in the Pacific. A railroad runs from Honolulu past Pearl Harbor to Schofield Barracks, where more of our soldiers are quartered than at any other place in the country.

For the tourist who is socially inclined Honolulu affords many opportunities for enjoyment. The nights are neither cold nor rainy and the charm of the sea shimmering in the light of the moon, while the stars are shining through a clear and balmy

atmosphere, tempt persons of leisure to prolong their social pleasures until a late hour. Well-bred people have no difficulty in finding congenial companions. Probably there are few places of its size where so many talented people reside or tarry for a time as in Honolulu. Musicians, artists, authors, scientists and statesmen may not be as numerous here as in New York or Washington but they are more accessible, if one wishes to see or to hear them.

Everywhere in the Hawaiian islands Japanese, Chinese, Portuguese and other people from Asia and Europe live in peace alongside of Hawaiian natives and people from the states. The women from the Orient usually wear the picturesque garb of their native land. How to make the public schools of the territory minister most effectively to the needs of the children of all races is a big problem. The visitor who would see the training given to young teachers to prepare them for this important work should visit the normal school at Honolulu, which continues in session during the first half of the summer.

At present the chief obstacle to spending a vacation in Hawaii is the expense. Railroad rates for summer tourists have been reduced since 1921, so that tickets from Ohio to the Pacific coast and return cost only $100, or about two cents a mile, with the privilege of stopping off anywhere. Transportation on the sea should be lower than on land, but at present it is twice as high, the minimum fare between San Francisco and Honolulu being $90 in either direction. The distance is only 2,100 nautical miles and the fare should be less than from New York to any of the European ports. For many tourists the greater cost for transportation on the Pacific is offset by the relatively calm sea through which the steamer plows its way in the summer voyage to Honolulu.

Living in Honolulu is rather expensive, perhaps on account of the presence of so many tourists and so many wealthy residents. Some persons who do not live like millionaires, when at home, insist on having the best of everything when traveling. Board at the big hotels in Honolulu is less expensive than at winter resorts in Florida or at the palatial hotels in large cities. Cottages at the famous Waikiki Beach bring a very high rental and rooms are not cheap anywhere in town. Sometimes it is possible to rent for a reasonable charge a furnished house whose owners are spending the summer in the states. Good meals can be had at the Y. W. C. A. or at Japanese restaurants for fifteen to thirty-five cents.

Tourist travel to Honolulu has been much greater since the war than ever before. In summer teachers constitute an important part of the passenger list, and their number will increase as the attractions of Hawaii become better known.

WHY ARE TYPHOONS IN CHINA SEA MORE FREQUENT THAN WEST INDIAN HURRICANES?

A correspondent of the Weather Bureau raises the above question. The reply by the Chief of Weather Bureau will doubtless be of interest to readers and is accordingly reproduced below:

"It is a definitely known fact that tropical cyclones have their origin within the region of calms of the Tropics, commonly known as the doldrums, and that cyclones form in this belt of calms only when it lies at an appreciable distance from the Equator. Now if nothing more than still, or relatively still, moist, warm air were essential to the formation of a cyclone of the Tropics then one would expect to find several in operation at the same time when this belt of calms lies say ten or more degrees either north or south of the Equator. But this does not follow, for it is our experience that the major part of a cyclone season may pass without the semblance of a hurricane, and rarely, if ever, do we note more than one cyclone at any one time in the West Indies. The foregoing being accepted as true, we must then seek a contributory cause of the formation of a cyclone outside the still, moist, warm air of the doldrums. Now, if we consider the seeming fact that the loci of tropical cyclonic formations on the North Atlantic are two in number, one the Western Caribbean Sea and the other the region about the Cape Verde Islands, where the belt of calms is at times flanked by oppositely directed systems of winds, one of which is the northeast trade of our hemisphere and the other the similar trade wind of the southern hemisphere, which after having crossed the Equator comes under the right-hand deflective influence of the earth's rotation, and is changed to a southwest wind system, it is reasonable to assume that these passing wind systems have perhaps much to do with the formation of tropical cyclones. Over the North Atlantic, within the Tropics, it is probably true that this contributory cause is rarely in operation, whereas in the East Indies the southwest monsoon blows during much of the cyclone season and on approaching, but passing to the south of the northeast trade wind system of the North Pacific Ocean, there naturally arise many occasions when the conditions are what may be regarded as ideal for the development of cyclones. Hence the greater frequency of the typhoon. Of course the deflective influence of the earth's rotation plays an important part in the changing of the course of these two primary wind systems (each one being turned to the right), and by doing so lowers the barometric pressure over the intervening region and in addition thereto determines the direction of rotation of the swinds of the cyclone itself. Now, if these primary wind systems initiate an incipient whirl, then the condensation of water vapor, and the consequent setting free of latent heat, immediately gives the energy that maintains the cyclone during days and at times weeks. Otherwise, it seems likely the life of the cyclone would be very short."—[*Monthly Weather Review*.

AUTOSUGGESTION IN TEACHING.

By Ervin S. Ferry,

Purdue University, LaFayette, Indiana.

For the past few years the Department of Physics of Purdue University has been segregating its students in general physics into sections, according to ability. If about one hundred students are assigned the same recitation hours, the group is divided into four sections. At the end of each period of six weeks the group is redivided according to the grades obtained during the period. By this segregation scheme we obtain sections that are fairly homogenous. We designate the sections by W, X, Y and Z,—W containing the students of highest grade and Z those of the lowest grade.

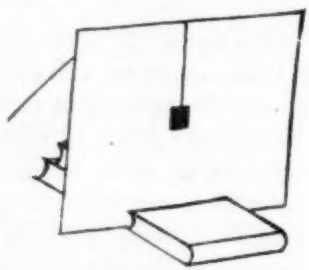
This semester the writer has a "Z" section of students of home economics. Few of these students successfully accomplished the work of the first week. Problems that give most "Z" sections little trouble could be solved by few of these students. Even definitions and statements of laws were not learned. The students seemed to be willing but frightened.

The phenomenon was so striking that an investigation was instituted at once. Several of the students said that it was impossible for them to concentrate their attention. They simply could not concentrate sufficiently to learn a definition or law. They thought they were somewhat abnormal in their inability to memorize. Some said that the solution of problems was quite beyond them. In so far as they could discover they had received no training in reasoning at any of their school or college work. In the conversations it transpired that several of the young women had been frightened by young men telling them that college physics is quite different than high school physics, that girls always have trouble with college physics because they do not have such power of concentration and reasoning as do the men, etc.

It was now perceived that the basis of the students' trouble was due to the idea that they were unable to concentrate the attention or to reason like other people. Malevolent autosuggestions were inhibiting their efforts. These autosuggestions must be neutralized before the students could accomplish results commensurate with their ability and effort. It would be quite futile to tell the students that they were quite normal and that the required work has been successfully done by generations of students just like them. An idea fully impressed on the mind

cannot be removed by a simple denial of its truth. It was thought that no purely verbal argument would suffice to counteract the harmful autosuggestions, and so resort was made to some simple experiments calculated to catch and hold the imagination. As these experiments probably have not been applied before to such a case as this, they may be of interest to other teachers.

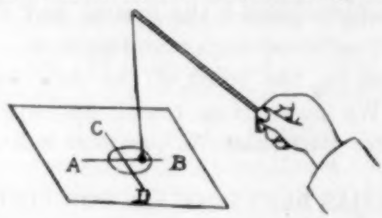
First, a piece of bright red paper, about one inch square and attached to one end of a white thread, was hung at the center of a white card about one foot square placed vertically on a table in front of the class, Figure 1. The class was told to fix the attention as strongly as possible on the red patch. At the



end of about thirty seconds, the red patch was jerked away and the class asked what was observed. About half of the class had observed a green spot where the red patch had been. These people were told that they had the power of attention well developed. The others were given a "flunk test" administered like the preceding except that now a blue patch of paper was used and the duration of the fixation of attention was increased to sixty seconds. This time, everyone saw a yellow spot where the blue patch had been. This showed that the entire class had the power to concentrate the attention. At once the class became intensely interested and quite willing to be shown that its opinion of itself was too modest in other respects, also.

The remainder of the experiments were performed with Chevreul's pendulum now considerably used by Baudouin and other psychoanalyists. A lead bullet or round solid dark colored glass bead nearly a centimeter in diameter is suspended from one end of a small rod by means of a piece of horsehair or very fine braided silk fish line about 20 cm. long, Figure 2. In addition, there is a sheet of paper on which is a cross and a circle about 5 cm. in diameter with the center coinciding with the intersection of the cross. The two arms of the cross are marked A-B and C-D.

In using this "pendulum," the student was asked to hold the bead as still as possible just clear of the table and directly above the intersection of the lines AB and CD. The arm must be free—not resting against the body or the furniture. The student was now directed to think intently of the line AB while keeping the eye fixed on the bead. It may help to keep the mind concentrated on the line AB if he repeats to himself "A-B," "A-B," etc. Within a couple of minutes the bead begins to oscillate along the line A-B, the amplitude gradually becoming



greater and greater. The student was now told that this experiment illustrates the law in psychology "an idea is able to release a force which by subconscious activities can realize the idea." For example, if his mind is filled with the idea that he will memorize a definition or that he will solve a problem depending upon principles which he knows, then he *can* memorize the definition and *can* solve the problem.

Again, proceeding as before, the student was directed to think intently of the line C-D. Within a couple of minutes the pendulum was swinging along the line C-D. While the pendulum was swinging along C-D, the student was directed to transfer his thought to the line A-B. Although the student tried to hold the pendulum still, the pendulum soon changed its path from C-D to A-B. The student was reminded that he did not think how the change of path was to be effected. He thought only of the end result. This experiment illustrates the law in psychology "when the end has been suggested, the subconscious finds means for its realization."

In the same manner the student was directed to concentrate his mind on the circle. The pendulum soon was describing a circular motion. While the pendulum was moving in a circular path the student was directed to try to keep the pendulum still but to think intently "I can't stop it." The pendulum continued in its circular motion, with even greater amplitude and speed. This illustrates the law "when an idea gives rise to a suggestion, all the conscious efforts which we make in order to

counteract the suggeston tend to intensify it." For example, if we think we are unable to accomplish a certain job, we cannot do it even though we try ever so hard. So long as we think a problem or a subject is impossible for us, we will not succeed however much we may try or however well we are prepared to do it.

After these demonstrations it was not difficult to displace the malevolent autosuggestions which had been inhibiting effective work. This was done by referring to the generations of students who had successfully passed the course and the many young women who had achieved high standing in it.

From this time on, the spirit of the class was very different from before. We now have reason to expect that a good proportion of this particular "Z" section will pass the course.

AMERICA NOW HAS BEST PROCESS FOR FIXING NITROGEN.

America now has the most effective method of fixing nitrogen of the air in such a way that it can be used as plant food in fertilizers or in making explosives.

Through scientific work at the Fixed Nitrogen Research Laboratory of the United States Department of Agriculture, a catalytic substance has been developed that brings about the fastest known reactions between hydrogen gas and nitrogen gas to form ammonia.

No formal announcement has yet been made as to the composition of the new catalyst, but Dr. Alfred T. Larson, under whose direction the research work has been carried on, revealed that it is made of iron oxide, aluminum oxide and potassium oxide. Since it is composed largely of iron its cost is very low. Methods for large scale commercial production have been perfected.

The new catalyst is declared to give yields at least twice as high as the best catalysts now known. Through the use of low temperatures and very high pressures, very high percentages of the gases are made to combine by this new catalyst. At a pressure of 1,000 atmospheres, sixty per cent conversion has been obtained.

The United States nitrate plant, No. 1, at Sheffield, Alabama, was designed for a process that can use this new iron catalyst of superior activity.

Shortly before the beginning of the World War, German chemists perfected the Haber process for the fixation of atmospheric nitrogen, which supplied Germany with nitrates when the usual supplies from the great nitrate beds of Chile were cut off by the blockade. The chemical composition of the catalyst used in the German plants has been jealously guarded as a trade and military secret. Even now American chemists do not know what substances are used in German plants to make the molecules of hydrogen and nitrogen gases get together and make ammonia.

The development of the catalyst used here has been an entirely independent achievement, and according to Dr. F. G. Cottrell, former director of the United States Bureau of Mines and now director of the Fixed Nitrogen Laboratory, "As far as we have been able to learn, there is no country in the world which has an ammonia catalyst superior to that developed by this laboratory."

Contrary to policy in every other country, no secret is being made of the results of the research work of government fixed nitrogen chemists. Full details are being given to all who are interested.

Large forces of chemists are understood to be at work in Germany, France, and Japan on similar problems and in all cases results are being withheld as trade or military secrets. In Germany, in spite of poor economic conditions, twice as many chemists are at work on this one problem as in the United States. England has a force of forty to forty-five scientists studying atmospheric nitrogen fixation, approximately the same number as at work here, and Japan spends as much on nitrogen researches as this government does.

Although over thirty-six per cent of the nitrogen produced in the world is now supplied by fixation of atmospheric nitrogen, less than one per cent of America's present requirements are supplied by atmospheric nitrogen fixed within this country. Only one commercial plant, located at Syracuse, N. Y., is operating using the synthetic ammonia process, and the catalyst used there is being kept a secret.

The government plant at Muscle Shoals, now idle, has a capacity only one-fifth of the 200,000 tons consumed in the United States at the present time. This large plant employs the cyanamide process, which if operated would not utilize catalysts perfected for the synthetic ammonia process.

With no large nitrogen fixation industry in this country, and with 3,000,000 to 4,000,000 tons of nitrogen, equivalent to 150,000,000 to 200,000,000 tons of commercial mixed fertilizers, being lost from land under cultivation and not replaced, the need of intensive nitrogen research to assure adequate nitrogen supplies in the future is declared to be imperative.—[*Science Service.*

SECRET OF VITAMIN'S IDENTITY NEAR SOLUTION.

One of the vitamins, the mysterious and unisolated food factors, has at last been obtained in a state of such purity that its early identification may be anticipated with certainty.

Dr. Atherton Seidell, chemist at the United States Public Health Service Hygienic Laboratory, has announced that he has been able to prepare from brewer's yeast a definitely crystalline compound that has the antineuritic properties of vitamin B.

He used fuller's earth to absorb from a solution of yeast the active vitamin principle and after precipitating with picric acid and subjecting this product to many solutions and crystallizations, pale yellow, transparent, crystalline flakes were obtained that in doses as minute as two milligrams a day protect pigeons from the effects that follow lack of vitamin B.

When a chemist obtains a crystalline substance it is usually only a matter of time until its identity can be established and its true chemical structure determined. With this information its synthesis frequently becomes possible.

"There has been a tendency in the past to regard vitamins as substances comparable with enzymes and toxines in their instability and marked activity of infinitesimal doses," said Dr. Seidell. "Acceptation of this view has, no doubt, deterred many from work on this problem, since the possibility of isolating substances of the nature of enzymes is very remote. It is distinctly encouraging, therefore, to obtain evidence that the antineuritic vitamin performs its function in doses of convenient magnitude and withstands ordinary laboratory manipulations. Assuming a satisfactory demonstration of these points, the final solution of the true chemical nature of vitamins may be anticipated with certainty."—[*Science Service.*

SUBTERRANEAN WATERS IN THE UNITED STATES.

The rocks that form the crust of the earth are not solid throughout but contain unnumerable holes, or open spaces, which range in size from minute pores to huge caverns. These open spaces, both large and small, are the underground reservoirs that feed springs and wells and furnish the water supply for most of mankind. Rocks are of many kinds, and they differ greatly in the number, size, shape, and arrangement of the open spaces which they contain, and hence in their capacity to hold and yield water. The occurrence of ground water in any region may therefore be determined by the character and distribution of the rocks by which it is underlain—that is, by the geology of the region.

The water-bearing openings in the rocks are the result of processes that have been at work on the materials of the earth through the long ages of geologic time, forming and altering the rocks. Most of these openings can be grouped into three main classes: (1) openings that existed in beds when the materials that formed them were laid down, such as the spaces between the pebbles that compose a bed of gravel or between the grains of a bed of sand or a sandstone; (2) cracks or joints into which the hard, brittle rocks, such as granite, quartzite, and slate, have everywhere been broken; and (3) crevices and caverns produced by the work of ground water, as in limestone. The water percolating through the rocks produces opposite effects in different places. In some places it creates large openings by dissolving the rock material; in others it fills the existing openings with the material that it throws down.

Gravel is the best kind of formation to carry and to yield water. In the United States gravel supplies the water to most of the strong wells, furnishing more water to wells than all other materials taken together. A well that ends in a good bed of gravel may yield more than a thousand gallons a minute. Next to gravel come sand, sandstone, limestone, and basalt, in the order in which they are named. Among the many kinds of rock that do not yield water freely but are nevertheless drawn upon where first-class water-bearing formations are lacking are fine-grained and poorly assorted unconsolidated deposits and hard rocks that have only tight joints. The most completely unproductive materials are the true clays and fine silts, which are too soft to have joints or other open spaces and whose pores are too minute to yield water.

The occurence of the water in rocks is profoundly affected by their structure. The dip or slope of the formations, the arches and troughs into which they have been bent, the fractures or faults that have been produced in the rocks by tremendous earth stresses, the irregularities of old land surfaces that were buried beneath younger sediments, the dikes or walls of rock that were formed by moulten lava, which was forced upward through cracks in the rocks—all these structural features affect the occurrence of the ground water. The driller who does not understand the significance of these features is bewildered by them, but if he studies them carefully they will give him clues by which he can forecast in advance of drilling the ground-water conditions in any locality.

For many years the Interior Department, through the Geological Survey, has been studying the ground-water resources of the United States, and it has published more than two hundred reports on this subject. One of the latest of these reports is a paper by O. E. Meinzer, Water-Supply Paper 489 United States Geological Survey, which sets forth the principles of the occurrence of ground water, states the geologic conditions favorable or unfavorable to its occurrence, and describes the ground-water conditions throughout the United States. The report forms a book of 321 pages and contains 141 illustrations, consisting of maps, pictures, and diagrams.

RESOLUTION REGARDING SCIENTIFIC CONGRESSES, CONVENTIONS AND MEETINGS.

Whereas, The work of scientific men has contributed enormously to the welfare of the human race and especially to the people of the United States of America, and

Whereas, The government of the United States has recognized the importance of scientific investigations and research by the creation of many scientific bureaus, and has appropriated large sums of money for carrying on their work which has been most beneficial to the health, industries, and commerce of this country, and

Whereas, Our people should be kept informed promptly and fully of the progress made and results accomplished by the scientific organizations of the government, and

Whereas, The members of the government engaged on scientific activities can only function to the best advantage by having conferences with scientific men of this country not in government service and with such men of other countries, and

Whereas, This contact can only be gotten by attendance at scientific gatherings in this country and abroad; therefore, be it

Resolved, That the Washington Academy of Sciences hereby petition and urge the President, the heads of departments of the federal government and the Congress of the United States to give the welfare of science in the United States their earnest consideration and assistance; and to provide by law and by appropriation of the necessary money for the attendance of such scientists of the government as heads of departments may designate at scientific congresses, conventions and meetings in this country; and for the attendance of such scientists of this country both in the government and in private life as may be recommended to the Department of State by competent authority and approved by the head of that Department or the official acting for him, as representatives of the United States of America at International scientific congresses, conventions and meetings. These appropriations would be exceedingly small as compared with the returns from them in great benefits to scientific advance in America and hence to the promotion of the national welfare. Be it further

Resolved, That a copy of these resolutions be sent to the President of the United States, the head of each of the executive departments, the President of the Senate, and the Speaker of the House of Representatives, and that they be published in the Journal of the Washington Academy of Sciences.

NEW FISH NAMED IN MOSELEY'S HONOR.

Professor E. L. Moseley's most recent discovery in the field of science is a new species of fish, discovered while on his vacation in the Hawaiian Islands during the summer of 1922. While there Professor Moseley made an extensive collection of fishes. Upon his return to this country, the local instructor left his collection with David Starr Jordan, the foremost authority on fishes of the Pacific Ocean. Mr. Jordan, on studying the collection declared that Professor Moseley had a fish of an unknown species. Months of investigation and research revealed this to be true.

As a result the Journal of the Washington Academy of Sciences has published a description of a new herring-like fish, named in honor of its discoverer, Professor Moseley, the Gonorhynchus Moseleyi.

Many other things in science, both in the plant and animal kingdom have been named in Professor Moseley's honor, because of his research and discoveries. The college feels that it has in Professor Moseley a man who is high authority in the biological sciences. It is indeed a privilege to work under such an authority.—[*Bee Gee News.*

PSYCHOLOGIST DISCOVERS WHY PROOF READERS MISS ERRORS.

A proof reader overlooks a greater number of mistakes on the right of a proof sheet than he does on the left, according to Dr. H. R. Crosland, assistant professor of psychology at the University of Oregon, who has just completed a two years' investigation into the causes of errors in proof reading. This is claimed to be the first thorough-going scientific investigation of its kind.

Dr. Crosland also discovered that there will be a greater number of errors overlooked in the lower half of the sheet than in the upper half. This is caused, he explained, by the tendency of the proof reader to become absorbed in what he is reading as he nears the end of the proof sheet, and also by fatigue.

Proof readers show no appreciable improvement in accuracy as the result of practice and experience, according to the investigator. This was attributed by him to the fact that in reading a line of type the eye passes from one fixation pause to another and does not directly focus on every character in that line. The length of fixation pauses, the number of letter spaces taken in by the eye during each pause, and the number of pauses per line, are all the result of heredity and very early environment. Therefore it follows that practice has little to do with the proof reader's ability to catch mistakes in printed matter.

Dr. Crosland found that it is not necessary to spend an undue length of time on a proof. "In fact, little kinship exists between the length of time spent in reading a proof sheet and the accuracy obtained by the reader," continued Dr. Crosland. "Indeed, there is evidence to show that the practiced proof reader takes too long to do his work."

The investigator believes the use of his tests will be of practical vocational value. In the course of his investigations he found he was able to predict with a high degree of accuracy the competitive rating which a given subject would make in a given series of the test by considering his record in the series already taken.

Thirty persons, consisting of journalism teachers, all of whom had previous newspaper experience, printers, and laymen were engaged in the experiment. Twenty proof sheets were read by each person, an interval of approximately one week elapsing between the reading of each sheet. The proof sheets were grouped in four series and each of the four series was read with a certain purpose in mind.

Readers were instructed to read for (1) accuracy, (2) for speed, (3) for meaning, and (4) with a stated time limit.

Thirty em proof sheets, the usual newspaper column, were employed in the tests.—[*Science Service.*

NEW BIOLOGICAL STATION LOCATED IN CANAL ZONE.

The wild, virgin jungle of Barro Colorado Island, in Gatun Lake, just off the steamship channel of the Panama Canal, will soon be the center to which scientists seeking the secrets of little known animals and plants will flock. Construction of biological station on that island has been begun by the Institution for Research in Tropical America, in which over twenty of the leading museums, societies, and universities of the United States are co-operating, Dr. A. S. Hitchcock, chairman of the executive committee of the organization, announced recently at the Smithsonian Institution in Washington.

The island was created by the formation of Gatun Lake in the building of the Panama Canal. It was one of the high spots in the tropical jungle

which was submerged to make the Lake, and contains over 3,000 acres. As the waters arose in the Lake, the forest animals took refuge on it in unusual numbers. Many jaguars, tapirs, and other large animals are known to exist on Barro Colorado, which is also an insect paradise and rich in plant materials.

Last June the government set the island aside as a reservation for biological research. No hunting, tree cutting, or settlement is allowed on it. The Institution for Research in Tropical America has been given custody of it and is now proceeding to erect a laboratory where biologists, entomologists, zoologists and botanists may find shelter for their apparatus and a place to set up their cots. James Zetek, of the United States Department of Agriculture, is serving as the local custodian of the station.

Barro Colorado is only a mile and a half from Frijoles Station on the Panama Railway ten miles from Gatun and ten miles from Gamboa. But although easy of access, the scientists working at the laboratory will literally have the wild at their door. Within a few feet of the station now under construction there is abundance of unstudied plants, animals and insects. The building will be screened and protected against the wood eating ants which abound in the tropics.

Not only has this government recognized the importance of panama as a field for biological study, Dr. Hitchcock said, but the Republic of Panama also recently set aside a beautiful site for a marine biological station on the bay front in the modern section of the city of Panama, next to the site of the Gorgas Memorial.

The Institution for Research in Tropical America operating the Barro Colorado site was initiated by the National Research Council and is an association including representatives of the American Anthropological Association, American Museum of Natural History, American Phytopathological Society, American Society of Agronomy, Brooklyn Botanical Garden, California Academy of Sciences, Carnegie Museum, Commercial Museum of Philadelphia, Ecological Society of America, Harvard University, Indiana University, Johns Hopkins University, National Geographic Society, New York Academy of Sciences, New York Zoological Society, University of Michigan, Philadelphia Academy of Sciences Smithsonian Institution, Yale University, University of Florida, America Genetic Association, and the National Research Council.—[*Science Service.*

High school teachers in Newark, N. J., receive the highest salaries paid for regular public school instruction in the United States, for they begin at $2,100 and reach $4,400 by annual increase, according to City School Leaflet No. 15, just issued by the Department of the Interior through the Bureau of Education. Casper, Wyo., a city of only about 12,000 people, pays to beginning elementary teachers $1,600 a year, which is $100 more than New York and Chicago pay for like service.

In general the great cities offer the best salaries, but their highest entrance salary, $1,500, is matched in some of the smaller places in the west including San Jose, Richmond, and Piedmont, Calif. Many other cities do nearly as well, and the sum which is paid most often to beginners is $1,000. At the lower end of the list is Savannah, Ga., which is reported in the leaflet as paying only $490, with annual increases of $36 to a maximum of $1,143. Colored elementary teachers in Rome, Ga., receive even less, for they begin at $382, and their maximum is $450. The salaries of teachers in elementary, junior high, and high schools are reported in the leaflet for nearly all cities of more than 2,500 inhabitants.

PROBLEM DEPARTMENT.

CONDUCTED BY J. A. NYBERG,
Hyde Park High School, Chicago.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and solve problems here proposed. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The Editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to J. A. Nyberg, Hyde Park High School, Chicago.

LATE SOLUTIONS.

815. *Claude Baldridge, Dorothy Welbourn, Evansville, Indiana.*

816. *Frank M. Phillips, Bureau of Education, Washington, D. C. Donald C. Steele, Greensburg, Pennsylvania.*

817. *C. E. Githens, Wheeling, West Virginia. Leonard Carlitz, South Philadelphia High School, Pa. N. H. Mewaldt, State Normal, Dickinson, N. D.*

818. *N. H. Mewaldt.*

819. 820. *Leonard Carlitz.*

SOLUTIONS OF PROBLEMS.

821. *Proposed by Burrell Morgan, Krollitz, W. Va.*

The hypotenuse of a right triangle is h and the side of the largest inscribed square is s. Find the sides of the triangle.

I. *Solved by J. K. Ellwood, Philipsburg, Montana.*

Let AB $= x+y$, AC $= x-y$. Then the equation of the areas

$$\triangle ABC = \triangle CFE + \triangle DBE + \text{square } AE$$

reduces to $x^2 - y^2 = 2sx$. This equation together with $2x^2+2y^2 = h^2$ (the Pythagorean equation) enables us to solve for x and y. Hence

$$2x = s+(h^2+s^2)^{\frac{1}{2}}.$$
$$2y = [h^2-2s^2-2s(h^2+s^2)^{\frac{1}{2}}]^{\frac{1}{2}}.$$

and from these equations AB and AC can be derived.

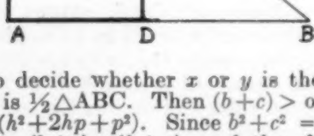
Insert figures

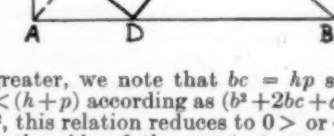
II. *Solved by J. F. Howard, San Antonio, Texas.*

Let AB $= c$, BC $= h$, AC $= b$. In the first figure let FE $= x$, the side of the square. In the second figure let AI $= p$, and GF $= y$.

In fig. 1, FC/FE = AC/AB or $x = bc/(b+c)$.

In fig. 2, AH/AI = GD/BC or $y = hp/(h+p)$.





To decide whether x or y is the greater, we note that $bc = hp$ since each is ½△ABC. Then $(b+c) >$ or $< (h+p)$ according as $(b^2+2bc+c^2) >$ or $< (h^2+2hp+p^2)$. Since $b^2+c^2 = h^2$, this relation reduces to $0 >$ or $< p^2$. Hence $(b+c) < (h+p)$, and therefore the side of the greatest square is $bc/(b+c)$ as in fig. 1. Then b and c can be found by solving the two equations $b^2+c^2 = h^2$, $b+c = bc/s$.

Also solved by *J. M. Barbour, Ardmore, Pa.; Michael Goldberg, Philadelphia, Pa.; R. T. McGregor, Elk Grove, Cal.;* and *Philomathe, Montreal, Canada.*

822. *Proposed by J. J. Sheekey, St. Joseph's Normal Institute, Ammendale, Md.*

If a^2, b^2, c^2 are in Arithmetic Progression show that $(b+c)$, $(c+a)$, $(a+b)$ are in Harmonic Progression.

Solved by Fred A. Lewis, University of Alabama.

If a^2, b^2, c^2 are in Arithmetic Progression, then $b^2-a^2 = c^2-b^2$, or $(b-a)(b+a) = (c-b)(c+b)$ or $(b-a)/(b+c) = (c-b)/(c+a)$. This equation can be written

$$\frac{1}{c+a} - \frac{1}{b+c} = \frac{1}{a+b} - \frac{1}{c+a}$$

which shows that $(b+c)$, $(c+a)$, $(a+b)$ are in Harmonic Progression.

Also solved by *J. Murray Barbour; J. F. Howard; James A. Gardiner, Wilmington, Del.; Michael Goldberg; Lindsay C. Marshall, Cambridge, Md.; R. T. McGregor; Philamathe,* and the *Proposer.*

823. *Proposed by Norman Anning, Ann Arbor, Mich.*

To cut an acute triangle into four triangles in such a way that their areas illustrate the identity.

$$\cos^2 A + \cos^2 B + \cos^2 C + 2\cos A \cos B \cos C = 1.$$

Solved by J. F. Howard, San Antonio, Texas.

Draw the altitudes AD, BE, CF and join D, E, and F. Then $\triangle AFE$, $\triangle BDF$, $\triangle CED$, and $\triangle DEF$ are the required triangles.

Proof. $\triangle AFE \sim \triangle ABC$ because $\angle A$ is common, and $AF/AC = AE/AB$ since each equals $\cos A$. Likewise, $\triangle BDF \sim \triangle ABC$, and $\triangle CED \sim \triangle ABC$. Hence

(1) $\triangle AFE/\triangle ABC = AE^2/AB^2 = \cos^2 A.$

(2) $\triangle BDF/\triangle ABC = BF^2/BC^2 = \cos^2 B.$

(3) $\triangle CED/\triangle ABC = CD^2/CA^2 = \cos^2 C.$

Because of the similiarity of the various triangles, we can write $<BDF = \angle A = <CDE$. Hence $<EDF = 180-2<A$. Then

$$\triangle DEF/\triangle ABC = FD\cdot DE\cdot \sin(180-2A)/AC\cdot AB\cdot \sin A$$

But $FD/AC = BF/BC = \cos B$; $DE/AB = CD/AC = \cos C$; and $\sin(180-2A)/\sin A = \sin 2A/\sin A = 2\cos A$. Hence

(4) $\triangle DEF/\triangle ABC = 2\cos A \cos B \cos C.$

Adding equations (1) to (4) gives the required identity.

Also solved by *J. Murray Barbour, Michael Goldberg,* and *Philomathe.*

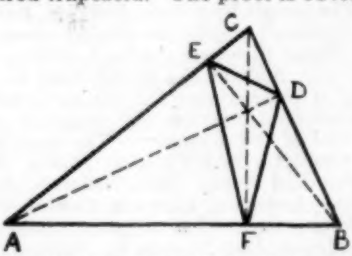
824. *Proposed by Jonas T. May, Mattoon, Ill.*

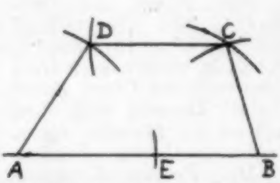
Construct a trapezoid given the four sides.

Solved by Michael Goldberg, Philadelphia, Pa.

Let the given sides be a, b, c, d, of which a and c are parallel.

Lay off $AB = a$, and AE, in the direction of B, equal to c. With E as a center and d as a radius draw an arc; and with B as a center and b as a radius another arc. Call C the point of intersection. With A as a center and d as a radius draw an arc; and with C as a center and c as a radius draw an arc. Call D the intersection point. Then ABCD is the required trapezoid. The proof is obvious from the construction.





Also solved by *F. A. Cadwell, St. Paul, Minn,* (four solutions); *T. E. N. Eaton, Redlands, Cal.; J. F. Howard; R. T. McGregor; S. A. Singer, Colum-*

bus, Ohio; Philomathe; Theodore Darby and *Mazie Urquhart, pupils of the Redlands H. S.;* and the following students of the *Culver Military Academy: Louis Bunnell, Gaylord E. Leslie, R. G. Stephens.* To the editor the above solution is a rather neat one because DC and AE are made parallel at the same time that they are made equal. And of the various ways of making lines parallel the use of a quadrilateral whose opposite sides are equal is more rapid and accurate than the use of alternate interior angles or corresponding angles.

825. *For High School Pupils.*

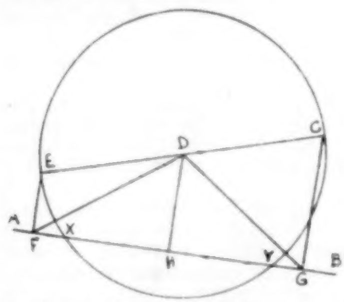
If from the extremities of a diameter perpendiculars be drawn upon any chord (produced, if necessary), the feet of the perpendiculars are equidistant from the center.

Solved by Albin Anderson, McHenry Community H. S., Illinois.

Given: The circle with center D, with the diameter EDC, with perpendiculars dropped from E and C to F and G, respectively, on the chord XY produced in both directions to A and B.

To prove that F and G are equidistant from the center D.

Proof: Draw the lines FD and GD.



Drop a perpendicular from the center of the circle, D, meeting AB at H.

EF and CG are perpendiculars to AB. (Given.)

and DH is perpendicular to AB. (Construction.)

Therefore EF, CG, and DH are parallel to each other because if two or more lines are perpendicular to the same line, they are parallel to each other.

ED and DC are equal because D is the center of the circle and all radii of the same circle are equal.

FH = HG because if three or more || lines cut off equal segments on one transversal they cut off equal segments on every transversal.

DH is the perpendicular bisector of FG because DH was constructed ⊥ to FG and FH equals HG.

DF = DG because any point on the perpendicular bisector of a line is equidistant from the extremities of the line.

∴ F and G are equidistant from the center D.

The proof is presented above exactly as written except for the deletion of the word "Now" in five places. The proofs by *Gilbert Kellams, Evansville, Indiana,* and *Mike Shepard, Cordova, Alaska* are almost identical with the above proof, step by step. These three are the best of the solutions. *Pearl Pound* and *Simpson Singer,* both of the North East H. S., Kansas City, Mo., deserve next mention for analyzing the various possible cases such as when the chord does or does not intersect the diameter, or is parallel to it, or is drawn from one end of the diameter. The next best solutions were by *Clara Buschulte, Opydyke, Ill.; Theodore Darby, Redlands, Cal.; Dorothy Hill, Keokuk, Ia.;* and *Henry Jack, Bellmore, Ind.;* also solved by *Mabelle Allen, Regina Anderson, Gertrude Cohen, Worcester, Mass.; Carolee Ditzler, Redlands, Cal.; Glen Hopkins, Hickman Mills, Mo.; Pauline Kennebeck, McHenry, Ill.; Murray L. Nolte, Frank Smith, North East H. S., Kansas City, Mo.; John Stover, Iowa City, Ia.; Mazie Urquhart, Redlands, Cal.; Louis Zisserman, So. Philadelphia H. S., Pa.*

Of the twenty pupils recorded here, 13 used the theorem "if three or more parallel lines . . . etc." and 7 did not. Four of the solutions used the theorem "any point on the perpendicular bisector . . . etc." to get FD = DG and 16 used the method congruent triangles. While the latter method is the more fundamental, the various other methods which are learned as the subject develops are more concise and lead to more elegant proofs. Eleven solutions used $\triangle$FHD and $\triangle$GHD; one used $\triangle$EFD and $\triangle$CGD; and four used $\triangle$DFX and $\triangle$DYG. In thirteen solutions the perpendiculars were constructed with ruler and compass. In four solutions the chord was drawn parallel to the diameter (but not so used in the proof).

While there has never been much uniformity in the lettering of figures, the editor is pleased to see that at least one new textbook, *Essentials of Geometry*, by D. E. Smith, states ". . . there is considerable advantage in lettering and in reading a figure counterclockwise. . . ." In any figure, then, A would appear at the lower left-hand vertex. The eidtor also follows the policy of using the letters of the alphabet in strict alphabetical order and labeling the points in the order in which they arise in the figure. The altitudes of a triangle are therefore always AD, BE, and CF. Of course such rules cannot be followed consistently when two figures are used in a single problem.

PROBLEMS FOR SOLUTIONS.

836. *Proposed by Richard Lewis, pupil at North East H. S., Kansas City, Mo.*

Volume 1 of "Boys Mechanics" offers a very interesting system of doing multiplication on the fingers. The simplest system deals with numbers between 6 and 10. Let each thumb represent 6, the first finger 7, etc., the last finger representing 10. Then let the fingers representing the numbers to be multiplied touch, using one finger of each hand, the palms facing each other. To find the desired product, add the number of fingers above and including the touching fingers times 10 to the product of the number of fingers below the touching fingers on one hand by the number of fingers below on the other hand.

837. *Proposed by Archie Blake, '24, Hyde Park H. S., Chicago.*

Given $a+b>c, \quad b+c>a, \quad c+a>b.$

Prove $2(a^2b^2+b^2c^2+c^2a^2)>a^4+b^4+c^4.$

838. *Proposed by Elmer Schuyler, Bay Ridge H. S., Brooklyn, N. Y.*

Construct a right triangle given r, the radius of the inscribed circle, and d, the distance between the centers of the inscribed and circumscribed circles.

839. *Proposed by R. T. McGregor, Elk Grove, California.*

Two parallel planes cut a sphere 12 in. in diameter into three equal volumes. Find the distance between the planes.

840. *For High School Pupils. Proposed by Nelson L. Roray, Metuchen, N. J.*

Prove that $\cos 20^\circ \cos 40^\circ \cos 80^\circ = \frac{1}{8}$

"In dollars how much does education increase the earning capacity of the young farmer?" is a question asked by some of the State agricultural colleges. The Georgia Agricultural College collected the facts from 1,271 farmers of that State and found that those who had no schooling earned on an average of only \$240 a year, those with a good common-school education earned \$565 a year, and those who had completed a high-school course earned an average of \$664. The men who had completed an agricultural short course and those who had graduated from the agricultural college were earning an average of \$1,254 a year. The Kansas Agricultural College had 1,237 reports. The average young farmer with a common-school education earned \$422 a year, the high-school graduate \$554. The men who had taken a short course in agriculture earned an average of \$859 a year, and the college graduate \$1,452.

SCIENCE QUESTIONS.

Conducted by Franklin T. Jones.

The White Motor Company, Cleveland, Ohio.

To Readers of School Science and Mathematics:

You are invited to propose questions for solution or discussion.

You are asked to answer questions.

Examination papers are always desired. Send in your own papers or any others. Some are interested in college entrance examinations, others in school or college examinations. All are desired.

Please address all communications to Franklin T. Jones, 10109 Wilbur Avenue, S. E., Cleveland, Ohio.

Acknowledgments.

The receipt of examination papers is acknowledged from Mass. Institute of Technology, Columbia University, and University of the State of New York (Regents).

QUESTIONS AND PROBLEMS FOR SOLUTION.

441. *Proposed by an airplane engineer.*

A dirigible condenses the water in the exhaust gases and retains them on the ship. Does the dirigible become lighter or heavier?

442. *The old "monkey and rope" problem recently mentioned by Carl Hering, Philadelphia, in* Science *(Feb. 15, 1924, p. 164).*

A supposedly weightless rope passing over a frictionless pulley has a ten pound weight hanging on one end and a ten pound monkey on the other.

What will happen when the monkey climbs the rope?

(Readers who desire may profitably put this before some lively boys in the form of a "project." Some 100 pound boy may want to try it out against a 100 pound weight.)

443. *Proposed by J. W. Wilbur, Peoria, Ill.*

If a cork is floated in a bottle partly filled with water and then air is pumped in under high pressure, will the cork rise higher or sink deeper in the water, or neither? (It is assumed, I suppose, that air does not penetrate the cork, and that its volume remains constant.)

EXAMINATION PAPERS.

444. *The following examination papers were recently put before a group of shop men who had been studying Electricity. Part of the work was done on the spot; part (the problems) were taken home to be done at leisure and the solutions handed in at the next class. In the original papers space was left between questions for the answers. What do you think of such an examination?*

ELECTRICITY.

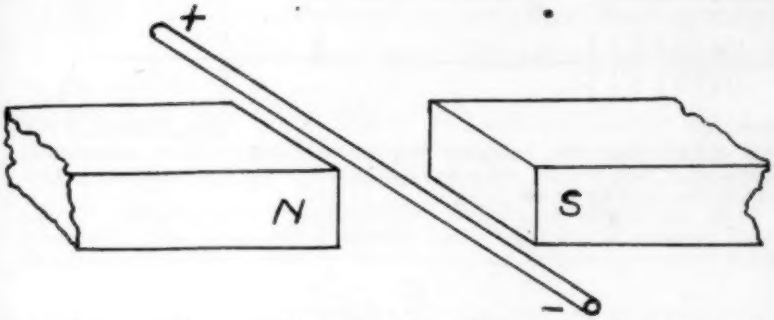
Examination No. 1.

February 8, 1924.

1. Draw the lines of force in the following sketches:

2. Mark the North and South poles in the following sketches:

3. Draw in the lines of force and show which way the conductor will move in the following sketch:



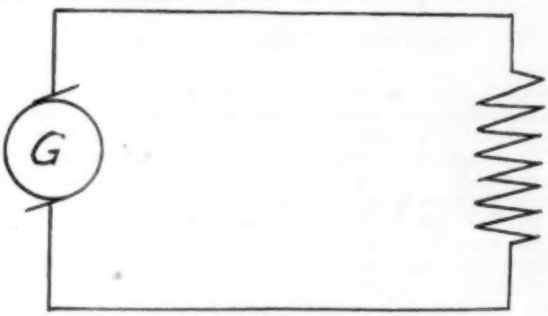
4. Draw two fixed resistances and an incandescent lamp in series with a generator:

5. Draw two fixed resistances and an arc lamp in parallel with a generator:

6. What is Ohms law?

Write the three forms of the formula for Ohms law.

7. Show how you would connect a voltmeter and an ammeter in the following sketch to measure the current flowing in the circuit and the voltage across the resistance:



ELECTRICITY.
Examination No. 2.

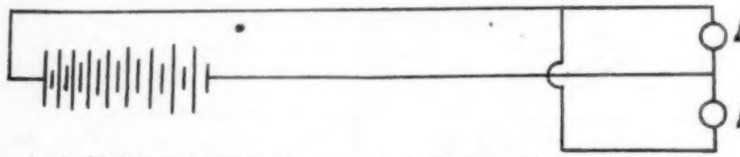
1 (a) What is a magnet?
   (b) What is a magnetic substance?
   (c) What are the poles of a magnet?
   (d) Which poles attract each other and which repel each other?
   (e) What is a magnetic field?
2 (a) What is an electro magnet?
   (b) Why are iron cores used in electro magnets?
3 Give the definition and symbol for:
   (a) Volt
   (b) Ampere
   (c) Ohm
4 Define the following:
   (a) Series Circuit
   (b) Parallel Circuit

ELECTRICITY.
Examination No. 3.

1. An electric toaster takes a current of 5 amperes. If it is to be used on a 110-volt current what must be its resistance?

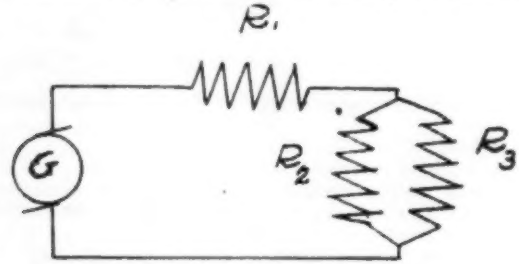
2. If a headlight takes 3 amperes, what must be its resistance if it is used on a 6-volt system?

3. The headlamps of an automobile are connected as shown in the sketch. If each has a resistance of 3 ohms and the voltage is 12, what is the total current flowing in the circuit?



4. A Christmas tree light can only stand 15-volts. How many such lights must you put in series so that you can light them from a 120-volt house lighting circuit?

5. In the sketch R = 8 ohms. R_2 = 5 ohms. R_3 = 20 ohms. If the brush pressure is 120 volts, what current is flowing in each resistance? What is the total current, and what is the voltage across each resistance?



SOLUTIONS AND ANSWERS.

415. *From an entrance examination paper of Columbia University, submitted by G. J. Meredith, Jr., West New York, N. J.*

A boy has an electrical device whose resistance is 12 ohms and which requires a current of 2 amperes. The only source of current available is 120 v D. C. and the only available resistances are 2 coils of 6 ohms and 16 ohms respectively. Show how these coils can be connected to give just the required current through the device.

Solution by F. H. Wade, Lewis Institute, Chicago.

Connect the stove in series with the 16 ohm resistance, then connect the 6 ohm resistance in shunt with the stove.

Resistance of stove and shunt $6 \times 12 / 6 + 12 = 4$ ohms

This being in series with a sixteen ohm resistance, the voltage 120 will divide according to the law of a series circuit as follows:

16/20 to the 16 ohm coil

4/20 to the stove and shunt

4/20 of 120 is 24 volts, which divided by the stove resistance, 12, gives current 2 amperes.

Comments on 415.

"The solution in the current (March) issue is *terrible.*"—

F. N. Wade.

"I think this is too difficult for the average high school student and I doubt if more than one member of my own class this year would be able to solve it; two years ago there would have been three or four who could do it without any question. The reason is simply what Professor Lovitt refers to in his article 'Disguised Facts' as the lack of developed detective ability. This lack shows itself in the physics class in the inability to apply any knowledge in any different way from that in which it was applied in the textbook."

Kenneth Hartley, Cheyenne Mountain High School,
Colorado Springs, Colo.

"Problem 415 seems to me to be unsuitable to be included in an examination for high school physics since consideration of all possible arrangements of the resistances (and this is the only method of attack I see) would consume too much time. However, it appeals to me very strongly as a daily assignment to challenge the efforts of the better students."

James W. Wilbur, High School, Peoria, Ill.

"I know plenty of high school pupils who could handle this problem."

E. A. Rae, San Jose, Calif.

Further comments will be published later.

Solutions of 415 were also sent in by

Christine Fischer, St. Louis, Mo.; E. A. Rae, San Jose, Calif.; J. W. Wilbur, Peoria Ill.; Kenneth Hartley, Colorado Springs, Colo.

436. From a Regent's examination in physics.

An inelastic mass of 12 pounds moving with a velocity of 25 feet a second hits squarely another inelastic mass of 3 pounds which is at rest, and the two masses then move on together. Find their velocity after impact.

Solution by James A. Gardiner, Wilmington, Del.

In all cases of impact, whether the bodies are elastic or inelastic, the total momentum of the two bodies is not changed by the impact. This can be stated by equation

Eq 1. $Mv+mu=MV+MU$

Eq. 2. $Mv+mu=(M+m)x$ where M,m are the respective masses of the two bodies,

v, u, are the initial velocities of the two bodies, respectively, and V, U, are the respective velocities of the two bodies after the impact. Since the bodies are inelastic they move with a common velocity after the impact, which we may call (x). This gives equation 2.

$$\text{or } x=\frac{Mv}{M+m}$$

$$X=\frac{25\times 12}{12+3}=$$

20 ft. per sec.

Also solved by R. T. McGregor.

437. From a Regents' Examination paper. Six 40-watt tungsten lamps are used 90 hours a month and an electric flat iron that requires 3 amperes is used 30 hours a month on a 110 volt current. Find the total cost of operation per month at 8 cents a kilowatt hour.

Solution by R. T. McGregor, Elk Grove, Calif.

Six 40-watt lamps used 90 hours a month gives $6\times40\times90/1000=21.6$ kilowatts, and a flat-iron that requires 3 amperes on a 110 volt circuit in 30 hrs. gives $3/110/30/1000=9.9$ kilowatts; hence the total number of kilowatts is $21.6+9.9=31.5$ kilowatts and at 8 cents a kilowatt, the cost will be $\$.08\times31.5=\$2.52$.

Also solved by J. A. Gardiner.

WILLIAM GAERTNER.

William Gaertner, president of The Gaertner Scientific Corporation, 1201 Wrightwood Avenue, Chicago, Illinois, has been awarded the Howard N. Potts gold medal by the Franklin Institute acting through its committee of science and arts.

This medal was awarded to Mr. Gaertner "in consideration of his notable achievement as a designer and maker of scientific instruments, materially contributing to the success of the research in physical science."

Mr. Gaertner, for twenty-eight years, has been the sole proprietor of William Gaertner & Company, makers of scientific instruments, formerly located at 5345 Lake Park Avenue, and at present he is the head of The Gaertner Scientific Corporation. He is recognized as one of the foremost scientific instrument makers in the United States, and is given credit for having emancipated American educational and scientific institutions, from their dependence on foreign-made scientific instruments.

NEW ENGLAND ASSOCIATION OF CHEMISTRY TEACHERS.

The Association: Its Past, Present and Future.

(Appeal for $1,000 Budget.)

With the twenty-fifth anniversary meeting close at hand, members of the N. E. A. C. T. are asked to consider what the association has been, what it now is and what it should in the future be.

What the Association Was.

Previous to the 1921 drive it was a Boston organization having a total membership of one hundred sixty-one. Three meetings a year were held near Boston. The association was a valuable aid to the teachers who came under its influence and was the means of starting and fostering many lifelong friendships among the science teachers of Eastern Massachusetts.

What the Association Now Is.

As a result of the Reconstruction Drive of 1921 the association was extensively recruited in Connecticut, Rhode Island, western Massachusetts and New Hampshire, and partially recruited in Maine and Vermont. Some of the immediate effects of this drive were

(a) Three meetings a year were increased to six.
(b) Three reports a year were increased to five.
(c) A $250 budget was increased to an $800 budget.
(d) A membership of 161 was increased to 400.
(e) Regional activity was begun in Connecticut, and western Massachusetts (in 1921), in Rhode Island (in 1921) and in New Hampshire (in 1923).

These changes have brought into active relationship to the association about three times as many members as heretofore. In order to direct the activities of the association more efficiently, a new constitution, now adopted in all divisions, was put into use. This created five additional executive officers, four division chairmen and an assistant secretary.

Although the drive of 1921 brought us a large increase in revenue, it was prosecuted at a great expense and it is only by practicing the strictest economy during the year 1923 that we are able to report the association back upon its feet, with all bills paid month by month and a small balance in the treasury. The economies effected have not served to detract seriously from the success of our meetings, however, which have been held according to schedule in our various divisions.

What the Association Should Be.

In what respects can the work of the association be made more effective in the future? What should we now undertake? See if you agree with the undersigned in the points suggested.

(1) Some attempt should be made to ascertain whether it is not time to begin to hold meetings in Maine where a membership of twenty-one was recruited in 1921 by Mr. Segerblom. This question can be decided only after consultation with the leading spirits among the science teachers in the vicinity of Portland.

(2) Funds should be available to enable the president and the division chairmen, in arranging their programs, to engage eminent speakers as in the past and to treat its guests becomingly.

(3) The association should purchase an addressograph at once. We have been using a borrowed addressograph for the past two years.

(4) Frequent bulletins, in addition to the regular reports of meetings should be issued. These might give current association news, notices of industrial trips, committee activities and appointments, etc. Money

should be available to provide for the mimeographing of this bulletin.

(5) The salaries of our secretaries should be assured and, if possible, increased. The reports of our meetings should be continued and these reports should be issued on time.

No doubt every member can think of other means of improvement.

OUR PLAN FOR A ONE THOUSAND DOLLAR BUDGET!

All of the suggestions above could be adopted if more money were available. This money should and can be raised. The best method is not by subscriptions, not by raised dues, but by increasing our membership.

HERE IS THE PROPOSED PLAN.

In preparation for each of our spring meetings, let us canvass New England to fill up our ranks with new members.

Let us raise our membership to 500.

Let us raise our budget to $1,000.

If the N. E. A. C. T. can put this over, it can accomplish all of the recommendations above. This will be a twenty-five per cent increase.

Does this mean another drive, like that of 1921?

That will not be necessary. Each division, under the leadership of its division chairman and with the help of its regular divisional executive committee, or of a special recruiting committee, can produce its small quota of the 100 new members in the ordinary course of advertising its coming meetings. These are at Malden, March 15, Mt. Holyoke College, May 3 and in New Hampshire, May 10.

The association is now printing 100 extra reports of each meeting for distribution to nonmembers. Several valuable reports are coming out right away. In addition to these regular reports, there will be printed about April 1 a special anniversary number. Many extras will be available.

Division chairman, recruiting committees and individual members are invited to call for these reports. Send the names and addresses of persons who should be invited to affiliate to the secretary, Laurence R. Atwood, Malden High School, Malden, Massachusetts. Application blanks, bulletins and sample reports will be distributed by him.

Begin as soon as you please upon this recruiting campaign, but let us consider the month of April as being devoted to recruiting new members. We should have 100 members by May 10, the date of our last spring meeting.

General science teachers as well as college teachers of chemistry should be invited to affiliate.

Try to attend all our meetings and trips within your reach. It is your presence and personal interest that will help the association most.

The undersigned will appreciate having members write him their views on the above suggestions; also, he will welcome any helpful suggestions looking towards making this association more efficient in its work. Such suggestions will be carefully considered, discussed at our meetings and perhaps made the subject of future bulletins.—[*S. Walter Hoyt, 20 Stone Road, Belmont, Mass.*

THE NEW ENGLAND ASSOCIATION OF CHEMISTRY TEACHERS.

The Twenty-fifth Anniversary Meeting.

(Reported by S. Walter Hoyt)

At the Malden High School on March 15 was held the 25th anniversary of the founding of the Association. At this meeting the first president, Dr. Lyman C. Newell of Boston University, and the tenth presi-

dent, Mr. Wilhelm Segerblom of Phillips Exeter Academy, delivered the principal addresses.

Dr. Newell gave an illustrated lecture on "Chemistry in the Earlier and Later Days in New England." Mr. Segerblom gave the final report of a questionnaire on "The Laboratory, its Aims and Proper Use." This questionnaire gives the consensus of opinion of 100 secondary school and college chemistry teachers on many points connected with the what, why and how of laboratory work. Other items on the program were reports of Central Division committees and a motion picture on paint manufacture by a representative of Wadsworth-Howland Company, through whose factory an industrial excursion was held in the morning previous to the meeting. Mr. Segerblom was elected to honorary membership in recognition of his long, faithful and effective efforts in behalf of the Association. Resolutions of congratulation were ordered sent to the recently formed Maryland Association of Chemistry Teachers, which takes away from the N. E. A. C. T. the distinction, heretofore held, of being the *only* organization of its kind in the United States that is exclusively devoted to the *teaching* of Chemistry.

At the anniversary meeting, the eighty-sixth in the history of the Association, four of the original sixteen who gathered at the Malden High School on February 19, 1898, were present and formed the centre of a picture of former and present executive officers, viz.: Dr. Newell, Mr. Clarence Boylston of Milton, Mr. George A. Cowen, and Mr. John W. Hutchins. Congratulatory messages were read from a fifth charter member, Dr. Henry P. Talbot, Dean of Massachusetts Institute of Technology, and from Dr. Francis Gano Benedict of the Carnegie Nutrition Laboratory, a former pupil, in the English High School, of our second president, also a charter member, Mr. Rufus Williams.

The Northeastern section of the American Chemical Society was also represented at this meeting by Dr. Jennings of Worcester Polytechnic institute and Dr. Arthur A. Blanchard, both of whom have also been N. E. A. C. T. members for many years, the former having entertained the Association at Worcester on the occasion of its sixty-eighth meeting in 1920 and the latter on several occasions at the Massachusetts Institute of Technology. Dr. Blanchard is a member of the advisory committee of the Central Division of the Association, together with Drs. Conant of Harvard, Harris of Simmons, Newell of Boston University, and Mr. Henry Black of the Roxbury Latin School.

The aim of the N. E. A. C. T. is to promote efficiency in the teaching of Chemistry. This aim has been accomplished in several ways: first, through the education of its members by providing them opportunity to hear prominent experts on chemical subjects; second, by making arrangements for monthly trips to industrial plants where chemical processes are employed, this being done through an industrial trips committee; third, through reports of committees on new books and Current events and publications in Chemistry. Occasionally, special projects looking towards the improvement of its members have been attempted, a trip to chemical industries in the vicinity of New York City, several Saturday courses at Technology, and the establishment of a library and museum at Boston University in 1911, when the Association was incorporated, being examples of this. Special investigations on subjects connected with chemistry courses, methods of teaching, etc., have often been assigned to qualified members and reports made on them.

A valuable adjunct to the work of the N. E. A. C. T. has been the rather full reports of proceedings which are published. These reports, preserved in the libraries of many of our members, form a distinct ad-

dition to the literature upon Chemistry, and its teaching. They, too, enable such teachers as are isolated from their fellow chemistry teachers by geographical location to, in a measure, profit by our meetings.

In commemoration of our twenty-fifth anniversary meeting, a report of unusual completeness will be issued. This will contain the unabridged report of "The Earlier and Later Days of Chemistry in New England" and will be illustrated by choice photographs of some of the more prominent older New England chemists selected by Dr. Newell, who is well qualified to deal with the subject, having made the history of chemistry a lifelong study. (Dr. Newell is secretary of the History of Chemistry Division of the American Chemical Society.) This special report will also contain the complete report on the Laboratory Questionnaire by Mr. Wilhelm Segerblom. Both of these papers will be valuable contributions to the literature of their respective subjects.

A great demand for this special number is anticipated, and to meet this the Association is printing a large number of extra reports, and will supply copies to non-members and *extra* copies to members at fifty cents per copy. Order of Mr. Laurence R. Atwood, Secretary, Malden High School, Malden, Mass. Send cash with order.

Other meetings of the N. E. A. C. T. already held this year are: the Brown University meeting held November 3rd at the new Metcalf Laboratory, and the Yale meeting, held December 10th at the Sterling Chemical Laboratory. The speakers at Brown were Dr. Gorham W. Harris of Simmons College, who spoke on "Some Chemistry of the Insect World," Dr. Simon of Brown University, who discussed "Photochemistry," and Professor Herbert F. Davison of Brown, who gave one of his very interesting lecture table demonstrations. At the Yale meeting, Mr. Earl R. Glenn of the Teachers' College, Columbia, spoke on "Standard Tests in Chemistry" and a paper on "An Investigation in Grading Chemistry Papers" by Asst. Professor Henry S. Johnson of University of Havana was read. The Association "sat in" on an illustrated lecture on "Colloids" by Professor P. T. Walden and, in the afternoon, a talk on "Some Unusual Uses of Paper" was given.

Spring meetings are to be held at Mount Holyoke College on May 3, and Concord, New Hampshire, probably on May 17. The Mount Holyoke meeting will be a joint meeting with the Connecticut Valley Section of the American Chemical Society.

The Association is now operating in four of the six New England States, has a New England-wide membership of 400, including representatives of nearly all New England colleges, and is about to begin on a campaign to raise its membership to the 500 mark. It will then endeavor to further extend its operations geographically.

S. Walter Hoyt.

The desire for better schools has made schoolhouse planning a highly specialized branch of the architect's profession, according to School Life, published by the United States Bureau of Education. With that specialization have come a few principles of comfort, utility, and beauty that are worked out in ways most suited to the particular place. In the Northern States the building is usually of brick with two or more stories and a basement, compact, well heated, and arranged to provide for comfort and efficient work in a rigorous climate. In the Southern States it may be a low, one-storied building with no basement and arranged on the unit plan. In the West and Southwest it is often of the mission style.

ARTICLES IN CURRENT PERIODICALS.

American Journal of Botany, Brooklyn Botanic Garden, for February, *$6.00 a year; 75 cents a copy.* "A Study of the Factors Concerned in the Reddening of Leaves of Diervilla Lonicera," Alice E. Keener; "The Effect of Hydroxyl-ion Concentration on the Growth of Walnut Roots," H. S. Reed and A. R. C. Haas; "Significance of the Behavior of Sensitive Stigmas II," F. C. Newcombe; "Succession of Fungi on Culture Media," Melville I. Cook; "The Flora of Epsom Lake," Harold St. John and Wilbur Doane Courtney; "Studies in Wood Decay IV. The Effect of Sodium Carbonate, Bicarbonate, Sulphate, and Chlorid on the Rate of Decay of Douglas Fir Sawdust Induced by Lenzites Saepiaria Fr. with Special Reference to the Effect of Alkaline Soils on the Rate of Decay of Wood in Contact with Them," Henry Schmitz.

American Mathematical Monthly, Ann Arbor, Mich., for February, *$5.00 a year, 60 cents a copy.* "Mathematical Methods in Economic Research," C. C. Morris; "Rahn's Algebraic Symbols," Florian Cajori; "The Three-Bar Curve," F. V. Morley; "The Dynamics of Monopoly," G. C. Evans; "Euler's Output, a Historical Note," W. W. R. Ball.

Condor, 514 Lester Ave., Pasadena, California, for January-February, *$3.00 a year, 50 cents a copy.* "Notes on the Life History of the Texas Nighthawk" (with four photos), Robert S. Woods; "Changing Habits of Vaux Swift and Western Martin" (with four photos), William L. and Irene Finley; "Autobiography of Joseph Mailliard" (with three photos),

Journal of Geography, 2249 Calumet Ave., Chicago, for February, *$2.50 a year, 25 cents a copy.* "The Bounds of Racial Geography," Robert M. Brown; "The Place of Geography in the Junior High School," W. R. McConnell; "Traditional Geography and the Present Trend," R. H. Whitbeck; "The Classification and Use of Geographic Principles," E. E. Lackey; "Geography in the Fourth Grade," Julia M. Shipman.

Nature Magazine, 1214 16th St. N. W., Washington, D. C., for March, *$2.50 a year, 25 cents a copy.* "Dinty, a Pet Procupine," William L. and Irene Finley; "Hell Diver," Howard T. Middleton; "From Boll to Bolt, J. S. Wannamaker; "Tornadoes—The Funnel Clouds," Gayle Pickwell; "Fungus Diseases That Destroy Insects," Paul G. Howes; "Autobiography of a Rolling Stone," William C. Alden; "The Maorauding Miller Moth," Charles Wilson; "Sugartime in the Maple Lot," Richard W. Westwood; "Trees and How to Plant Them," Charles L. Pack; "Pittsburgh Blazes a Trail;" "Our Common Red Newt," Agnes Kuhn; "Nature Study Review," Anna B. Comstock; "Nature Lore as a Handicraft," William G. Vinal; "Nature Study for Our Children," Herbert J. Stack; "Nature Games," E. Lawrence Palmer.

Photo-Era Magazine, Boston, Mass., for February, *$2.50 a year, 25 cents a copy.* "The Golfer Tries a Bromoil," David R. Craig; "Table-Top Photography," W. J. Turnbull; "Your Eye is Better than Your Ground-glass," Studio-Light; "Kinematography for the Amateur, Part IV," Herbert C. McKay; "Nature-Studies in Winter," Mary E. Howe; "When Winter Comes". (Poem), William Ludlum; "Teaching a Child the Use of the Camera," G. H. McKelway; "The 'Still' Cameraman," Shirley Vance Martin; "Practical Observations of a Photo-Finisher," E. N. Musgrave.

Popular Astronomy, Northfield, Minn., for March, *$4.00 a year, 45 cents a copy.* "The Reform of the Present Calendar Begun," William F. Rigge; "The Real Uses of Astronomy, Sidereal and Planetary," William H. Pickering; "The Effect of Cosmic Clouds on the Period of Variable Stars," Luis Rodés; "American Astronomical Society: Reports of Observatories"; "Thirty-First Meeting of the American Astronomical Society," with Plate V (Frontispiece); "Occultation of Aldebaran 1924, April 8," William F. Rigge; "Observation of the Heavens," Frederic R. Honey.

School Review, University of Chicago Press, for March, *$2.50 a year, 30 cents a copy.* "Supervised Study in Elementary Physical Science," Wilbur L. Beauchamp; "A Study of High-School and First-Year Uni-

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versity Grades," Douglas E. Seates; "Is the Pedagogically Accelerated Student a Misfit in the Senior High School?" Margaret M. Alltucker; "The Qualities Essential to a Dean of Girls," Elsie M. Smithies; "Examinations in the High School," Hugh A. C. Walker; "The Professional Training of High-School Teachers," L. H. Whitcraft; "How is Supervised Study Doing," A. W. Burr.

Scientific Monthly, Garrison, N. Y., for March, *$5.00 a year, 50 cents a copy.* "The Origin, Nature and Influence of Relativity," George D. Birkhoff; "Modern Conceptions of Earth History," J. Harlem Bretz; "The Functions of the Endocrine Organs," R. G. Hoskins; "The Development of Asymmetry," T. H. Morgan; "The Need of Integration of Attitudes Among Scientists," Kimball Young; "Edward Livingston Youmans, a National Teacher of Science," H. G. Good; "Some 'Social Nuisances,'" Dr. W. W. Keen; "The Biotic Factor in Forestry," Edward N. Munns.

BOOKS RECEIVED.

The Story of a Great School Master, by H. G. Wells. Pages xi+176. 13.5x20 cm. Cloth. 1924. Macmillan Company, New York City.

Louis Pasteur, by S. J. Holmes, University of California. Pages ix+246. 13x19.5 cm. Cloth. 1924. Hancourt, Brace & Company, New York City.

Safety First for the School and Home, by Harriet E. Beard, public schools, Detroit, Michigan. Pages ix+223. 13.5x19.5 cm. Cloth. 1924. The Macmillan Company, New York City.

Carnegie Foundation for Advancement of Teaching Eighteenth Annual Report. Pages v+166. 19x25.5 cm., Paper. 1924. 522 Fifth Avenue, New York City.

Cyclic-Harmonic Curves the Study of Polar Co-ordinates, by Robert Moritz, University of Washington. Pages 58+20 plates. 18x25 cm. Paper. 1923. Washington University, Seattle.

University of Illinois Proceedings of the High School Conference from 1923, by H. A. Halster, University of Illinois. Pages 392. 15x23 cm. Paper. 1924. University of Illinois, Urbana.

Eighth Yearbook of the National Association of Secondary-School Principals, edited by H. V. Church. Pages lxxii+222. 16x24 cm. Paper. 1924. H. V. Church, Cicero, Ill.

General Science Syllabus, by J. C. Loevenguth, Junior High School, Wichita, Kansas. Pages viii+63. 14x19 cm. Cloth, 1923. World Book Company, Yonkers, N. Y.

Supplement to the New World, by Isaiah Bowmann. 98 pages. 16x24 cm. Paper, 1923. World Book Company, Yonkers, N. Y.

Household Mechanics, by Earl L. Bedell. 32 ex. 20x24 cm. Paper. 1923. 55c. Manual Arts Press, Peoria, Ill.

Charts and Graphs, by Karl G. Karsten, Consulting statistician. Pages xl+724. 16x23. Leather, 1923. Prentice-Hall, New York City.

Backward pupils in New York City high schools will henceforth be required to take a simpler course than the other pupils. When the new term opens in February the boys and girls in the lowest fifth of the school group will take modified courses in which science and manual work will be substituted for the usual mathematics and modern languages. Programs will be arranged so that backward pupils will have either extra recitations or more time for supervised study and individual instruction, Elimination of mathematics and modern language will leave time for this extra work. Typewriting, shop work, biology, and general science will be on the programs for the various modified courses, the administration of which will be at the discretion of the principals.

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MANUSCRIPTS. Contributions on Science and Mathematics Teaching are invited. Articles must be written on one side of the sheet only. All illustrations must be drawn or written in jet black on a separate sheet of manuscript. Contributors are requested to write scientific and proper names with particular care. Manuscripts should be sent to the Editor of **School Science and Mathematics, 5517 Cornell Ave., Chicago,** or to the proper departmental Editor. Books and pamphlets for review should be sent to the Editor. To insure insertion in any number, manuscript must be in the editor's *possession not later than the 20th of the second month before* publication.

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BOOK REVIEWS.

The Pilot Arithmetics, Book One, by Lou Belle Stevens, supervisor of Primary Arithmetic, New Rochelle, N. Y., and James H. Van Sickle, Superintendent of Schools, Springfield, Mass. Pages 272. 14x19 cm.

Book Two, by Harry B. Marsh, head of the Mathematics Department, The Technical High School, Springfield, Mass., and James H. Van Sickle. Pages 304. 14x19 cm.

Teachers' Manual for Grades One to Four, by Lou Belle Stevens, and James H. Van Sickle. Pages 256. 14x19 cm. 1923. Newson & Company, New York.

Book One covers the work of grades three and four. It utilizes the experiences that have already made a direct contribution to the child's knowledge of number, enlarges the significance and application of this knowledge and creates situations that stimulate consecutive, sustained thinking and makes new contributions to the child's experiences.

Book Two presents the work for grades five and six, throughout the book simple and practical methods and forms of operation are chosen. At first the problems are based largely on the immediate interests and experiences of the pupils, and then broaden out into wider fields of activity. Oral exercises always precede written work. There are many local problems in which the pupil is expected to furnish his own data, and many topics of especial interest to children.

The *Manual* aims to help teachers to provide their pupils with a definite and satisfactory foundation in number, to build upon this foundation, and to extend the formation of good habits to the processes of multiplication and division.

H. E. C.

History of Mathematics, by David Eugene Smith, LL. D., Professor of Mathematics, Teachers College, Columbia University. Volume I. General Survey of the History of Elementary Mathematics. Pages xxii+596. 14x21 cm. $4.00. Ginn and Co., Boston, Mass.

This work outlines the main current of the development of the mathematics from prehistoric times down to the nineteenth century in a style that is not only as fascinating as that of a well written novel but also as clear and precise as mathematical standards demand. The volume in hand treats the development of mathematics chronologically in ten main periods from "prehistoric mathematics" down to "the eighteenth century and after," grouping the events of each period in subdivisions mainly according to countries. The remarkably limpid style makes the volume easy reading and gives it high rank as a piece of American literature. In a work of this character one expects to find precise facts and specific references to the sources, and the writer does not fall short in this respect. But he has achieved a unique success in keeping his main text unburdened with dry details, while furnishing in the footnotes just the right additional information to meet the probable inquiries of various types of readers. The deftness with which he steers a smooth course between the "too little" and the "too much" is almost uncanny.

The work is unique also in the manner in which the growth of mathematics is exhibited in connection with the growth of the race along other lines, in the skillful way in which mathematicians of the past are made to stand out vividly as human personalities, in its numerous portraits and reproductions of documents, in the very helpful and suggestive lists of "Topics for discussion" that follow the various periods, and by no means least in the chronological table which concludes the work and which is

in itself a masterpiece exhibiting with remarkable clarity the chief milestones of mathematics down the ages placed in position in the onward march of the culture of the race.

Much of the work can be read with interest and profit by the high school pupil while few professional mathematicians will fail to find it a survey that gives delight as well as more or less of new information and a refreshingly clear grouping of the chief events in the development of the science.

It is unnecessary to give a more detailed account of the contents Every student of mathematics should become acquainted with the work at first hand. In every library for English speaking users, high school, college or university, institutional or personal, this volume should indubitably be the next work on the history of mathematics to be acquired.

A second volume is promised, to treat the evolution of certain topics in a connected fashion. The readers of the first volume will await the appearance of the second with impatience and with extremely high expectations. In volume I the author has set himself a trying standard; it will be no mean task to produce in volume II a work reaching the high level of excellence attained by volume I.

J. W. A. Y.

Teaching First Year Chemistry, Notes and Suggestions, by J. O. Frank, Professor of Chemistry in the Wisconsin State Normal School at Oshkosh, Wis. Second edition, revised and enlarged. Pages 64. ½x15.5x23 cm. Paper covers. 1924. $1. Published by author, J. O. Frank, Oshkosh, Wis.

This new edition of Mr. Frank's helpful work for chemistry teachers contains much that will be invaluable to beginning teachers.

The purchase of apparatus, the equipment of laboratories, methods of teaching and of examining, the content of the course (here Mr. Frank quotes the report of the committee of the American Chemical Society on "A Standard Minimum Outline of High School Chemistry) the departmental library, and other helps in teaching are among the topics that are considered. Part II gives a brief outline for teaching qualitative analysis.

An excellent list of subjects and materials for project teaching is accompanied by a list of addresses of firms from whom samples of materials and booklets on products can be obtained. A bibliography and list of reference books is furnished.

Altogether this book will be found extremely useful by the inexperienced teacher and even the older members of the profession will find much that is new and valuable in it.

F. B. W.

The Carbon Compounds, A Textbook of Organic Chemistry, by C. W. Porter, Associate Professor of Chemistry in the University of California. Pages ix+494. 2½x16x23½ cm. Some line drawings. Cloth. 1924. $4. Ginn & Co.

This new book is built around the course in organic chemistry as taught to sophomores at the Univerity of California. It pretends only to be an elementary course in the fundamentals of the subject.

The author has dared to give, at the outset, some of the newer views in regard to valency, including a brief outline of the electron theory. He admits the unsettled state of some of this theory but believes it better to teach some of it even though later on it has to be revised. Another innovation is the introduction of a chapter on the ammonia system of compounds, in which the relations of several organic substances to water and to ammonia are discussed.

The order of treatment of the organic compounds is similar at the outset to the customary one, the aliphatic compounds being the first to be presented.

The last 100 pages are devoted to the discussion of general organic reactions. The headings of this part of the text follow: Introduction, Hydrolysis, Acetoacetic Ester and Malonic Ester, Oxidation Reduction, Addition Reactions and Thiele's Theory of Partial Valence, The Grignard Reaction, The Friedel & Crafts Reaction, The Perkin Reaction, The Sabatier & Senderens Synthesis, Gabriel's Synthesis, Structural Rearrangements, Kopp's Law, Appendix, Questions & Problems for Review, another Index, Subject Index.

The introduction is especially good, giving the student who will read it an excellent bridge to cross the seeming gap between inorganic and organic chemistry. Brief methods of analysis leading up to the finding of formulas are given. Every college teacher of organic chemistry will want to see this new text and it should find a place in many a high school departmental library.

F. B. W.

Quantitative Analysis, Containing Theory, Laboratory Directions, Problems, Explanations of Calculations and Special Topics in Analytical Chemistry, by Stephen Popoff, Ph. D., acting Head of Analytical Chemistry, State University of Iowa. Pages xiii+342. 1½x14x19½ cm. 28 illustrations. Cloth. 1924. $2.25. P. Blakiston's Son & Co.

The incorporation of the underlying principles and theory into this text book of quantitative analysis is a bit novel and would appear to be good practice as it forces a review of material that has presumably been previously learned and shows at once its application to the matter in hand. The application of the mass law and the theory of equilibrium to quantitative reactions is especially stressed in the text.

Part IV includes a course in electrometric titrations. College teachers of quantitative analysis will want to examine this text.

F. B. W.

The Story of a Great School Master, by H. G. Wells. Pages xi+176. 13.5x20 cm. Cloth, 1924. Macmillan Company, New York City.

This is an account or biographical sketch of F. W. Sanderson, for many years head master of the Undle School. It is written in a manner as only H. G. Wells can do it. Mr. Wells did not become acquainted with this man until about eight years before his death, but when investigation as to the best school to which he should send his sons, he came in contact with this great school master. The personality of the man so impressed itself upon the author of the book that he was obliged to write a splendid biography of him.

It is a good book that all persons aspiring to teach boys and girls the best way of living, should read and put into practice.

C. H. S.

Safety First for the School and Home, by Harriet E. Beard, Public Schools, Detroit, Michigan. Pages ix+223. 13.5x19.5 cm. Cloth. 1924. The Macmillan Company, New York City.

A book which is very valuable because of the special matter which it treats. Without question it is a book which ought to be read by all parents and teachers. It is an awful fact that in the United States out of every one hundred people who die, six of these deaths are violent deaths, and are those caused by carelessness of some person or other. If proper protection had been taken these six people would not have been killed.

When we stop to think of this as a fact it is simply appalling. The American people must wake up to the fact that this slaughter must be stopped, and really the only way it can be done is to create a sentiment throughout the country which will cause the people to become more careful. This can best be done through the public schools and churches—especially the schools, for emphasis must be laid before them which will teach that carelessness cannot be tolerated.

The book stresses especially industrial safety. Suggestions are given for instruction in all the grammar grades. It is a fine book, and demands an extensive sale which doubtless it will have.

C. H. S.

University of Illinois Proceedings of the High School Conference from 1923, by H. A. Halster, University of Illinois. Pages 392. 15x23 cm. Paper. 1924. University of Illinois, Urbana.

This is a compilation of the papers and an account of the proceedings of the conference which was at the University of Illinois, by the high schools of the state, in November of 1923. It is well arranged and tabulated. The writer of this only wishes the bulk of the matter had been put up in ten point instead of eight point type.

C. H. S.

Louis Pasteur, by S. J. Holmes, University of California. Pages ix+246. 13x19.5 cm. Cloth. 1924. Hancourt, Brace & Company, New York City.

Much has been said and written about this great Frenchman, Louis Pasteur, but most of the biographical sketches are so large, and in the sense of the word, complicated, that they really prevent the ordinary layman from reading an account of his life work. This is comparatively a small volume, 246 pages, which gives the gist of the man's life work, touching upon the high points especially. A fine account is given of Pasteur presented in connection with his scientific work. It is believed that this text will have a wide circulation and thus continue to perpetuate the life and character and teachings of this great man.

C. H. S.

The Magic of Communication, by John Mills. 38 pages. 15x22.5 cm. Paper. 1923. American Telephone and Telegraph Company, 195 Broadway, New York.

This is a very helpful little pamphlet for all people, young or old, who are interested in communicating from place to place either by wire, wireless, or radio. It contains a little history concerning telegraphy and many practical suggestions as to how the work is done. Every person reading this little account should send for a copy at once.

C. H. S.

Science Laboratory Notebook. 17x21 cm. Paper. 1923. Fordham Publishing Company, 175 Fifth Ave., New York City. Price twenty-five cents.

This is a convenient form of notebook if an instructor desires his pupils to follow rigid rules in writing up his results of his experiments. A set of general directions are given at the outset, which the student should follow; also there is an instructors' certificate provided to certify the work done by the pupil. There is a place for the pupils' index and necessary data accompanying the experiment. In the rear of the book are some formula and physical constances. There are about fifty pages in the book.

C. H. S.

Back numbers of School Science, School Mathematics, and School Science and Mathematics may be had for 30 cents a single copy. The Mathematical Supplements for 15 cents a copy.

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School Science and Mathematics, Vols. XVIII, XIX, XX, XXI, XXII, and XXIII, each	2.50

Self-Proving Business Arithmetic, by Thomas T. Goff, Head of the Department of Commercial Arithmetic, State Normal School, Whitewater, Wis. Pages xv+316. 13x19 cm. 1923. The Macmillan Company, New York.

The author presents as the basis for the students' work the plan of requiring the student to prove the correctness of his own work before turning it in. This book eliminates all the topics customary to arithmetics that have no bearing on business, and includes topics necessary to modern business not found in many less modern texts. The student learns how to read understandingly an insurance policy, a stock certificate, a bond, a tax schedule, and so on. In every possible detail this arithmetic correlates with bookkeeping without overlaping. The Exercise Book to accompany this text will undoubtedly appeal to the student to do neater and more careful work. Each sheet provides for two different solutions for each problem and is arranged to make checking easy. Teachers of commercial courses should examine this book.

H. E. C.

New Plane Geometry, by Fletcher Durell, Ph. D., Head of the Mathematical Department, The Lawrenceville School, and E. E. Arnold, M. A., Superintendent, The Public Schools of The Pelhams, N. Y. Pages 327. 13x19 cm. 1924. Charles E. Merrill Co., New York.

The revision of the Durell and Arnold *Plane Geometry* has been based mainly on two ideas: To make the subject simple and easy at the outset, and to make the students' ability to solve original exercises the criterion of real success in the study of geometry. More than 150 new, simple and varied originals have been added to the large number in the former edition. The simple and informal introduction to geometry with easy exercises and drawing problems should develop in the student a real grasp of the subject. The group method of teaching originals and the free use of algebraic and other methods of analysis are of real value. The exercises in practical applications in geometry and in the construction of ornamental designs, given early in the course and continuing throughout, help the students to understand the advantage of a knowledge of geometry in his future work. H. E. C.

Vegetable Crops, by Homer C. Thompson, B. Sc. Professor of Vegetable Gardening, Cornell University. Cloth. 478 pages. 32 illustrations. 15x23 cm. Published by McGraw-Hill Book Co., Inc., New York, 1923.

This book is intended to meet the needs of colleges and universities in the line of vegetable gardening. The author has attempted to bring together the results of experimental and research work in this subject. This has never been done in any comprehensive way. When the literature of experimental work is widely scattered it is difficult to make successful use of it, and Professor Thompson has done a great service in making it easily available.

The author has specialized on the principles of growing and handling vegetable crops, putting the emphasis on the science of gardening rather than on the art of gardening. All phases of gardening are taken in successive chapters from soils and soil preparation, fertilizers, seeds and seed growing, forcing devices, transplanting, cultivation, irrigation, intensive cropping, diseases, marketing, and storage to the consideration of individual crops.

This is a good book for reference for the teacher of botany. Everything he needs will be found within its covers.

W. W.

Ascaris Megalocephala. An outline of the Life History, Anatomy and Cytology of the Horse-Ascaris, by Morris Miller Wells, Ph. D. Paper. 24 pages. 15x23 cm. Illustrated with outline drawing and photomicrographic plates. Published by the General Biological Supply House, Chicago. 1924. $1.

We quote from a prefatory statement by the author and publisher: "This booklet is one of a series of Scientific Pamphlets published by the General Biological Supply House. Each booklet is prepared by a scientist whose training lies in the special field presented. We believe you will find that the facts herein contained have been concisely and accurately presented. The horse-ascaris has been much discussed in biological literature and has been used largely in textbooks and manuals to illustrate the phenomena of fertilization, maturation and cleavage. Mr. Wells has done a useful piece of work in gathering together the facts and arranging them in usable form in this booklet.

W. W.

Laboratory and Field Work in General Botany, by E. N. Trauseau and H. C. Sampson, Professors of Botany, The Ohio State University. Loose leaf binding. Paper. 21x27 cm. 154 pages with blank spaces for notes. Published by the World Book Company. 1924.

This is a students laboratory manual of botany to accompany Professor Trauseau's textbook of "General Botany" recently reviewed in this *Journal.* It is designed, of course, for college students. There are about 40 exercises covering a year's work in general botany for college students. There are also appendices with lists of reference books, chemicals and special reagents and an elaborate time schedule for quarters iand semesters.

The book is very carefully worked out and executed. It should be of much assistance to high school teachers of botany and biology for reference and for suggestions of methods adaptable to secondary school needs.

W. W.

Botany, Principles and Problems, by Edmund W. Sinnott, Professor of Botany, Connecticut Agricultural College. Cloth. 385 pages. 240 illustrations. 15x23 cm. Published by McGraw-Hill Book Company, Inc., New York. 1923.

This is a textbook for college freshmen. As such the book is not of primary importance to teachers of secondary school botany and biology, but as an up-to-date textbook of botany presenting its material in a manner that is fresh and stimulating and to some extent novel, it is certainly of great interest to botanists in the high school. The illustrations are many of them original and very helpful. The subject matter, while following the usual order of development, has some chapters showing the modern trend of botany studies. We refer to the chapters on the "Soil and its Importance to Plants," "Heredity and Variation" and the two chapters on "Evolution" theories and the evolution of the "Plant Kingdom." These chapters are very fine, but the most important innovation, differentiation from the ordinary textbook, lies in the extensive use of "questions for thought and discussion" and the "reference problems." These questions and problems are not only very suggestive and interesting, but they serve to connect the subject matter of the book with practical everyday problems, thus linking up scientific botany with the many and far-reaching phenomena which the science underlies and explains.